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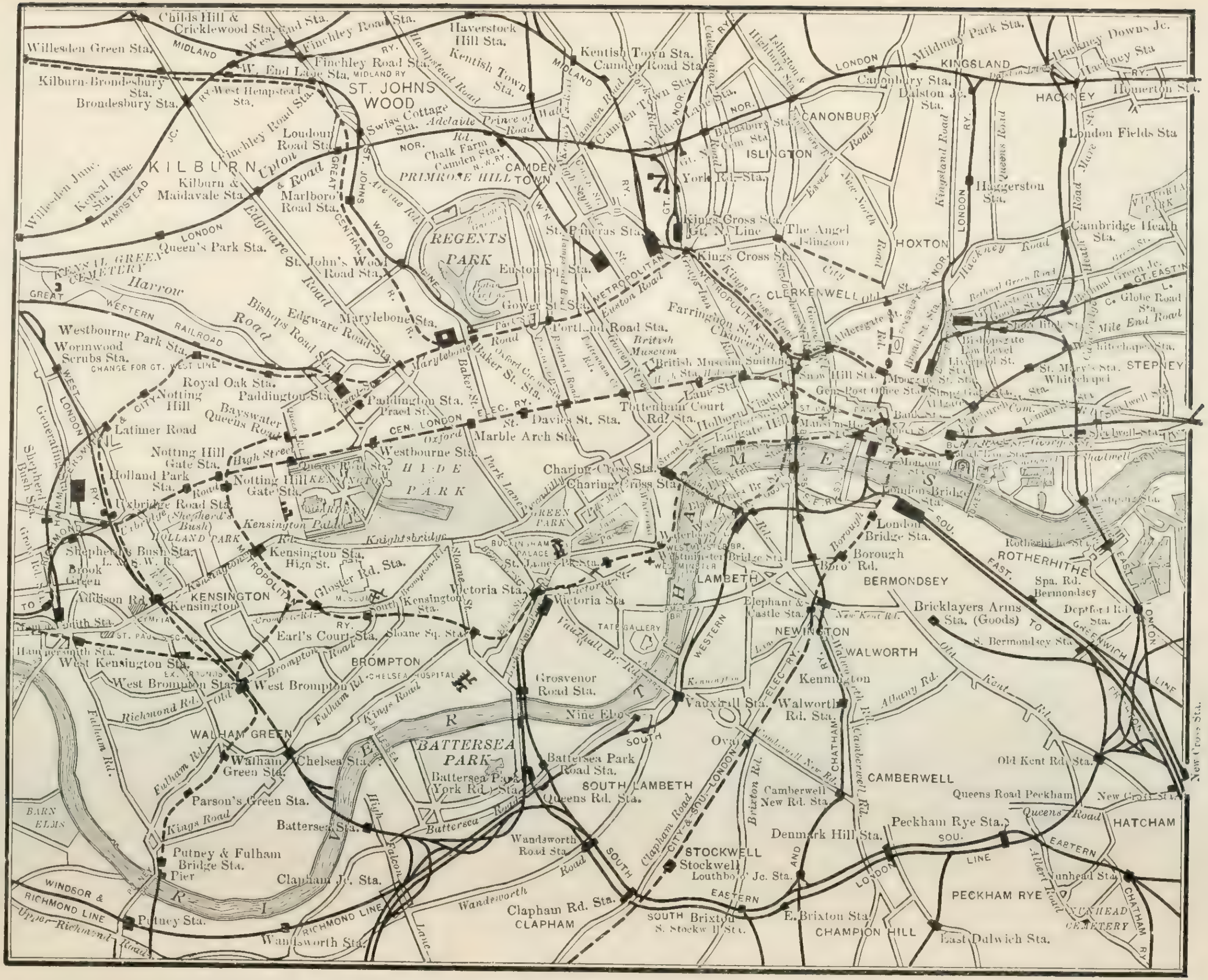

MAP SHOWING THE EXISTING RAILWAYS OF LONDON, SURFACE LINES BEING INDICATED BY SOLID LINES AND UNDERGROUND ROADS BY DOTTED LINES.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

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THE RAPID-TRANSIT PROBLEM IN LONDON.

By Frank J. Sprague.

Mr. Sprague's conclusions, presented in this article, are the result of over six months' concentrated study of the problem of rapid transit in London. He brings to it the ability which pioneered electric-tramway development in the United States—for the Richmond road, the first trolley line, was his creation, and on it and about one hundred and fifty more of which he was the promoter are patterned the essentials of the modern trolley system. His system has been introduced on the Chicago South Side, the Brooklyn, and the Boston elevated railways and on the Versailles division of the Western Railway of France. As a leading exponent of rapid-transit electric service, he offers this solution of the greatest and most revolutionary development in city transportation now presented to the world.—THE EDITORS.

WITHIN twelve to fifteen miles of Charing Cross lies an area of 690 square miles, with a resident population of nearly six millions of people. But a little over one-sixth of this area contains three-fourths of this population, say four-and-a-half millions. The number of people who daily enter and leave London is indicated by the fact that there are no less than seventeen main railway stations within a radius of two miles, and fully three hundred local and suburban stations.

The movement of the traffic in the City of London proper, the centre of the financial activity of the world, is suggestive. Although but a square mile in area, with a day population of about three hundred thousand, and a night population of but a tenth of this, in a single day over a million-and-a-quarter of people and one hundred thousand vehicles enter and leave its limits.

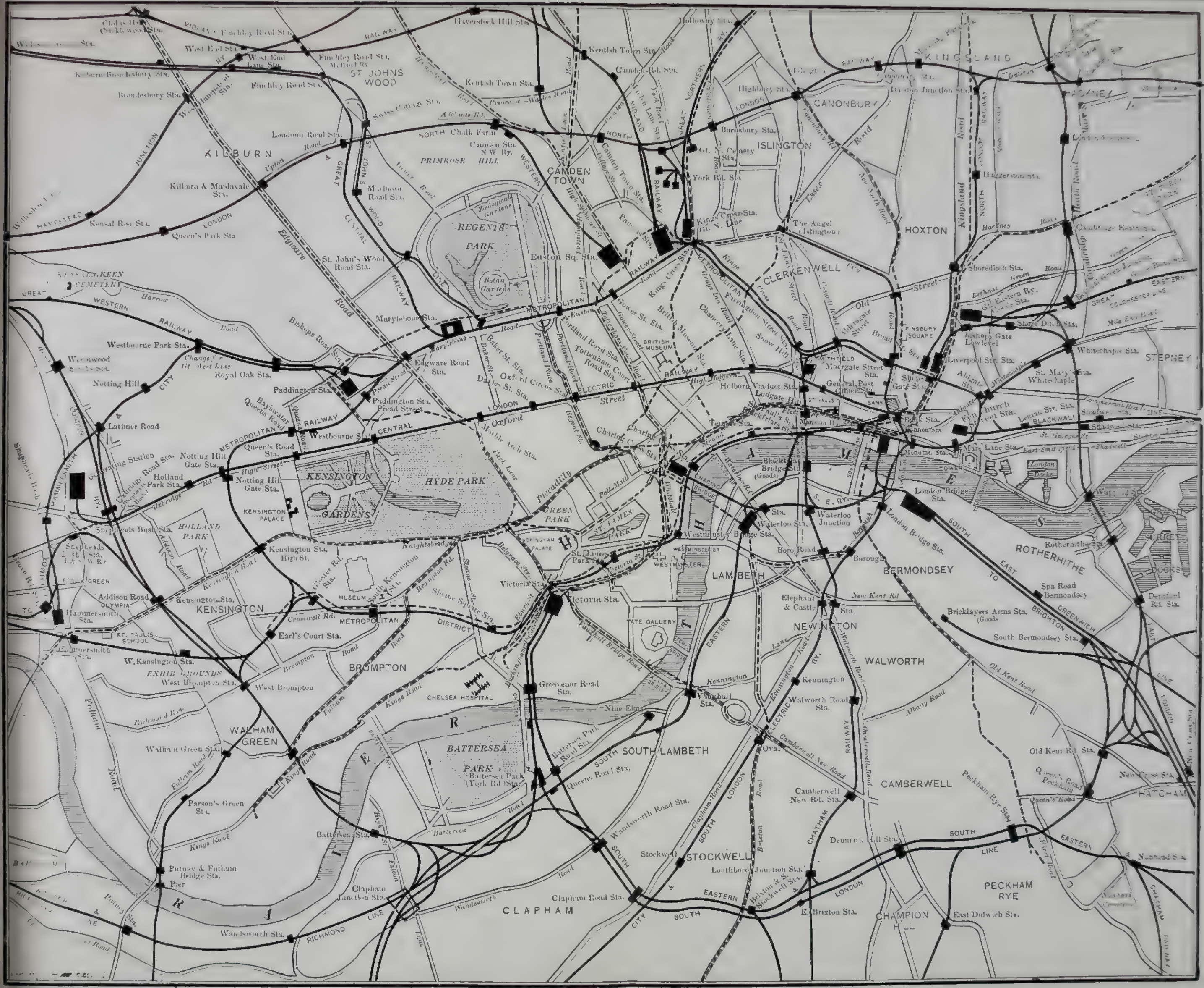
The general street traffic is carried on by about 200 miles of tramways, nearly one hundred and fifty lines of omnibuses, and twelve thousand cabs. Internal communication is also provided by two lines of underground railways, with suburban connections, and three deep-level roads operated electrically. Two lines are under construction, six more authorized, and Parliamentary rights are sought by existing or new companies for thirteen railways, or modifications or extensions thereof.

The map facing this page shows the steam and electric roads in operation in the heart of London, and those under construction, authorized or projected, the latter being shown in broken lines. Each of these proposed schemes is promoted on the merits of a particular route, with little regard to any other, and some of them are of doubtful value. In consequence, all new applications were recently referred to an eminent general Parliamentary committee composed of six members each of the House of Lords and House of Commons, which, after three months of inquiry, has referred most of the schemes to select committees, with a report containing certain advisory and mandatory restrictions.

Measured by the needs of London, this report is not entirely satisfying. In brief, it recognizes the necessity of rapid transit; recommends underground roads which can connect with surface tramways and 'busses in outlying districts; suggests that they run from centers of traffic to other like centers, and to the suburban districts; advises shuttle working at the City ends of roads, instead of loops, while permitting them at the outer ends; opposes confluent conjunctions, and congestion of stations; and endorses the multiple motor (unit) system. One of the most important of all questions is but referred to without definite action as being without the terms of reference,—that is, the placing of the whole rapid-transit problem under a permanent board with full power to deal with it in all its aspects, without which no satisfactory solution of the general problem is possible.

Of course, in dealing with this subject, existing conditions must first be considered. Most important of the existing roads for internal traffic, and admitting of the greatest possibilities, are the existing Metropolitan and the District Railways, with their extensions, for they hold the key to any immediate improvement in the rapid-transit situation in London. They may be described as composed of an Inner Circle (or ellipse) about 13 miles around, with branches radiating and looping in various directions. The stations average half-a-mile apart.

Unlike the roads of later construction, they are of the "cut and


KILBURN
ST JOHNS WOOD
PRIMROSE HILL
CAMDEN TOWN
ISLINGTON
CANONBURY
KINGSLAND
HACKNEY
HOXTON
CLERKENWELL
REGENTS PARK
Zoological Gardens
Botan Gardens
FINSBURY SQUARE
BRITISH MUSEUM
STEPNEY
HYDE PARK
KENSINGTON GARDENS
KENSINGTON PALACE
GREEN PARK
ST JAMES PARK
BUCKINGHAM PALACE
WESTMINSTER
LAMBETH
HOLLAND PARK
KENSINGTON
MUSEUM
BROMPTON
CHELSEA HOSPITAL
TATE GALLERY
BATTERSEA PARK
WALHAM GREEN
SOUTH LAMBETH
NEWINGTON
WALWORTH
BERMONDSEY
ROTHERHITHE
SURREY DOCKS
London Docks
TOWER
CAMBERWELL
STOCKWELL
CLAPHAM
PECKHAM RYE
CHAMPION HILL
HATCHAM
T H A M E S
R I V E R
Kensal Green Cemetery
Edgware Road
Oxford Street
Piccadilly
Knightsbridge
Cromwell Rd.
Kings Road
Fulham Road
Old Kent Road
Kensington Road
Euston Road
Marylebone Road
GREAT WESTERN RAILWAY
METROPOLITAN RAILWAY
CENTRAL LONDON RAILWAY
DISTRICT
GREAT NORTHERN RAILWAY
MIDLAND RAILWAY
NORTH LONDON RAILWAY
LONDON & NORTH WESTERN
SOUTH EASTERN
LONDON CHATHAM & DOVER RAILWAY
LONDON BRIGHTON & SOUTH COAST
SOUTH WESTERN
CITY & SOUTH LONDON ELECTRIC RY.
BLACKWALL
GREAT EASTERN
RICHMOND LINE
Haverstock Hill Sta.
Kentish Town Sta.
Camden Rd. Sta.
Holloway Sta.
Finchley Road Sta.
West End Sta.
West End Lane Sta.
Kilburn Brondesbury Sta.
Brondesbury Sta.
Swiss Cottage Sta.
Loudoun Road Sta.
Chalk Farm
Camden Sta. N W Ry.
Kilburn & Maidavale Sta.
Kensal Rise Sta.
Queen's Park Sta.
Marlborough Road Sta.
St. John's Wood Road Sta.
Euston Sq. Sta.
Camden Town Sta.
York Rd. Sta.
Kings Cross Sta. Gt. N. Line
Barnsbury Sta.
Highbury Sta.
Dalston Junction Sta.
Haggerston Sta.
The Angel (Islington)
Shoreditch Sta.
Cambridge Heath Sta.
Westbourne Park Sta.
Royal Oak Sta.
Paddington Sta.
Paddington Sta. Praed Street
Edgware Road Sta.
Marylebone Sta.
Baker St. Sta.
Portland Road Sta.
Gower St. Sta.
Kings Cross Sta.
Farringdon Street Sta.
Aldersgate Street
Moorgate Street Sta.
Bishops Gate Lowlevel
Liverpool Str. Sta.
Shore Ditch Sta.
Whitechapel Sta.
St. Mary's Sta. Whitechapel
Aldgate Sta.
Fenchurch Street Sta.
Leman Str. Sta.
Shadwell Sta.
Mark Lane Sta.
Monument Sta.
Cannon Sta.
Bank Sta.
General Post Office Sta.
Holborn Viaduct Sta.
Ludgate Hill
Mansion H.
Temple Sta.
Blackfriars St.
Charing Cross Sta.
Tottenham Court Road Sta.
Oxford Circus Sta.
Bond St. Sta.
Marble Arch Sta.
Lancaster Gate
Queen's Road Sta.
Westbourne St.
Notting Hill Gate Sta.
Holland Park Sta.
Shepherds Bush Sta.
Uxbridge Road Sta.
Notting Hill
Latimer Road
Wormwood Scrubs Sta.
Hammersmith Sta.
Addison Road Olympia
Kensington Sta. High St.
Gloster Rd. Sta.
South Kensington Sta.
Sloane Square Sta.
Victoria Sta.
St. James Park Sta.
Westminster Bridge Sta.
Earl's Court Sta.
W. Kensington Sta.
West Brompton Sta.
Walham Green Sta.
Parson's Green Sta.
Putney & Fulham Bridge Sta.
Wandsworth Sta.
Clapham Junction Sta.
Battersea Sta.
Battersea Park (York Rd) Sta.
Battersea Park Road Sta.
Queens Road Sta.
Grosvenor Road Sta.
Nine Elms
Vauxhall Sta.
Wandsworth Road Sta.
Clapham Road Sta.
Stockwell
Oval
Kennington
Walworth Road Sta.
Elephant & Castle Sta.
Boro Road
Borough
Waterloo Sta.
Waterloo Junction
London Bridge Sta.
Spa Road Bermondsey
Bricklayers Arms Sta. (Goods)
South Bermondsey Sta.
Rotherhithe Sta.
Deptford Rd. Sta.
Old Kent Rd. Sta.
Queen's Road Peckham
New Cross Sta.
Peckham Rye Sta.
Denmark Hill Sta.
Camberwell New Rd. Sta.
Loughboro Junction Sta.
Brixton & S. Stockwell Sta.
E. Brixton Sta.
East Dulwich Sta.
Nunhead Sta.
Wapping Sta.

N. 3 London [illegible]

cover" type, brick-arched, and with flat road beds. Built at a cost, in parts, of nearly a million sterling per mile of line, they represent franchises and occupy rights of way which cannot be duplicated. They connect almost every important railway terminal, and many centers of business activity. They are close to the surface of the street, and the stations are roomy and easily accessible. The traffic rails are in a common tunnel which is frequently connected to the open, and can be perfectly ventilated. This tunnel is large enough to take any type of standard car, and to permit of any kind of equipment.

Although planned for connecting the terminals of existing railways, as well as for local transit, the original scheme has been largely subordinated, for the Inner Circle is now a common trunk line over which are run not only Circle trains, but trains from outlying roads. These railways, therefore, now present one of the strangest anomalies of railway operation, for while each owns *in toto* a part of the Circle, and jointly a connecting link, each runs Circle trains in one direction only on one track, trains from outlying sections over both tracks, and each must provide way for trains of other companies.

At present, they are unfortunately under separate managements, as well as subject to running rights which interfere with a reasonable schedule. The class system and compartment cars characteristic of long-distance lines are maintained, while fares vary materially, and in many instances are almost prohibitive. The present operation is a travesty on rapid transit. The Inner Circle presents a ten-minute service between the upper and lower halves, while with stations half-a-mile apart, and with no grades or curves worth mentioning, a schedule of only 11½ miles an hour is maintained. The atmosphere is foul from the use of steam and the accumulations in the tunnels. The station waits are double what are necessary, and the delays are augmented by changing of engines.

Recently, after many years of abuse, and only after being driven to it by the great loss caused by the competitive operation of the Central London Railway, which bisects the Inner Circle, a serious move is being made to equip the tunnels, and later the outlying lines, with electricity. The equipment is temporarily delayed by disagreement between the two roads as to the proper system to adopt, which by the time this article goes to press will probably have been decided, as provided in a recent bill, by arbitration.

The eventual natural solution of the problem, so far as these roads are concerned, is their operation under one management, the abandonment of running rights of other roads over the Circle tracks, and equipment with a system which permits of the highest practical schedule, and trains varying in length and frequency according to service requirements. The circle should be an exclusive highway, not a trunk stem for several railways, especially unless these are similarly equipped. The joint operation of steam and electric trains in the tunnel is of course not permissible, and until electric equipment is adopted on the branches there must necessarily be a delay of either passengers or trains at junction points. The needs of the traveling public as a whole will be much better met by a high-speed two-minute service on the Circle, with interchange of traffic at junction points, than by a ten-minute service, mixed with half-a-dozen outlying services which must in turn be also subordinated to the exigencies of local traffic.

The three deep-level roads, the City and South London, the Waterloo and City, and the Central London, built to relieve in some measure specific cases of congestion, and to provide for more direct means of communication with the City, are of the tubular type, as are all of the proposed railways. They are driven through the London clay, are constructed with separate tunnels for each line of way, with station gradients, and follow existing streets. The shells of the tunnel are built up of iron rings bolted together, and grouted on the outside with cement under pressure. The depth below the streets varies from 40 to 150 feet, so that in addition to stairways there are provided lifts of great capacity. On the Central London Railway alone there are forty-eight of these, which have carried over 400,000 passengers in one day. The roads are of standard gauge, but the diameters of the tunnels vary from 10 feet 6 inches to 16 feet, the latter being the only one which can take a standard car.

All afford splendid examples of civil engineering and construction, and the general features of the Central London in particular have been worked out with remarkable care and detail. The electrical equipment for the rolling stock on none of these roads, however, is in accord with the latest accepted developments in electric traction, which are contrary to locomotive practice and fixed make-up of trains. The disadvantages of this practice are particularly felt on the Central London because of the impracticability of reducing train intervals; and for the purpose of increasing frequency and getting more traffic, this road recently applied for authority to extend its tracks by loops at each end. The Parliamentary committee has expressed itself as opposed to such extension at the City end, because of the number of roads having City terminals and the probability of the multiple-unit system being the preferable one in the future.

Much has been said on the subject of vibration, because of complaints in connection with the operation of the Central London Railway, and an eminent committee has been appointed by authority of Parliament to consider the cause and its remedy. Both seem clear. The trains on this road are pulled by electric locomotives weighing 45 tons, equipped with four gearless non-spring-borne motors. Rails of shallow section are carried on longitudinal stringers laid in cement to distribute the load over several of the tube sections, and hence transmit any blow directly to the shell. The concentration of weight and the hammer-blow delivered by the motors and trucks, without intervention of springs, seem ample reason for any possible complaints, which, however, are somewhat exaggerated. If instead of this equipment the train were made up of two four-car units under suitable control, each unit having a pair of motors at each end mounted in the usual fashion, then with the weight reduced, distributed, and in part spring-borne, vibration would be practically destroyed.

Deep-level roads must be generally considered apart from the standard railways which enter London, although vital in any scheme of transit. As at present projected they are limited routes between centers or along routes of congested traffic, and means for interchange of traffic between the terminals of the great railways and centers of business, or they may constitute trunk arteries to supply tramways radiating from outer terminals. Having but two tracks, they must always be excluded from express service. Tubular railways are, however, probably the only ones which will be constructed in London, because vested interests and the enormous cost make almost impracticable the construction of additional surface, overhead, or shallow-tunnel lines, although if London could be brought to entertain any such radical treatment of the problem as New York has done, shallow tunnels after the plan of those now under construction there and in Paris would be advisable in some streets. But any road should be authorized only as a part of a well-planned general scheme of traffic, under the supervision of a central authority fully alive to London needs.

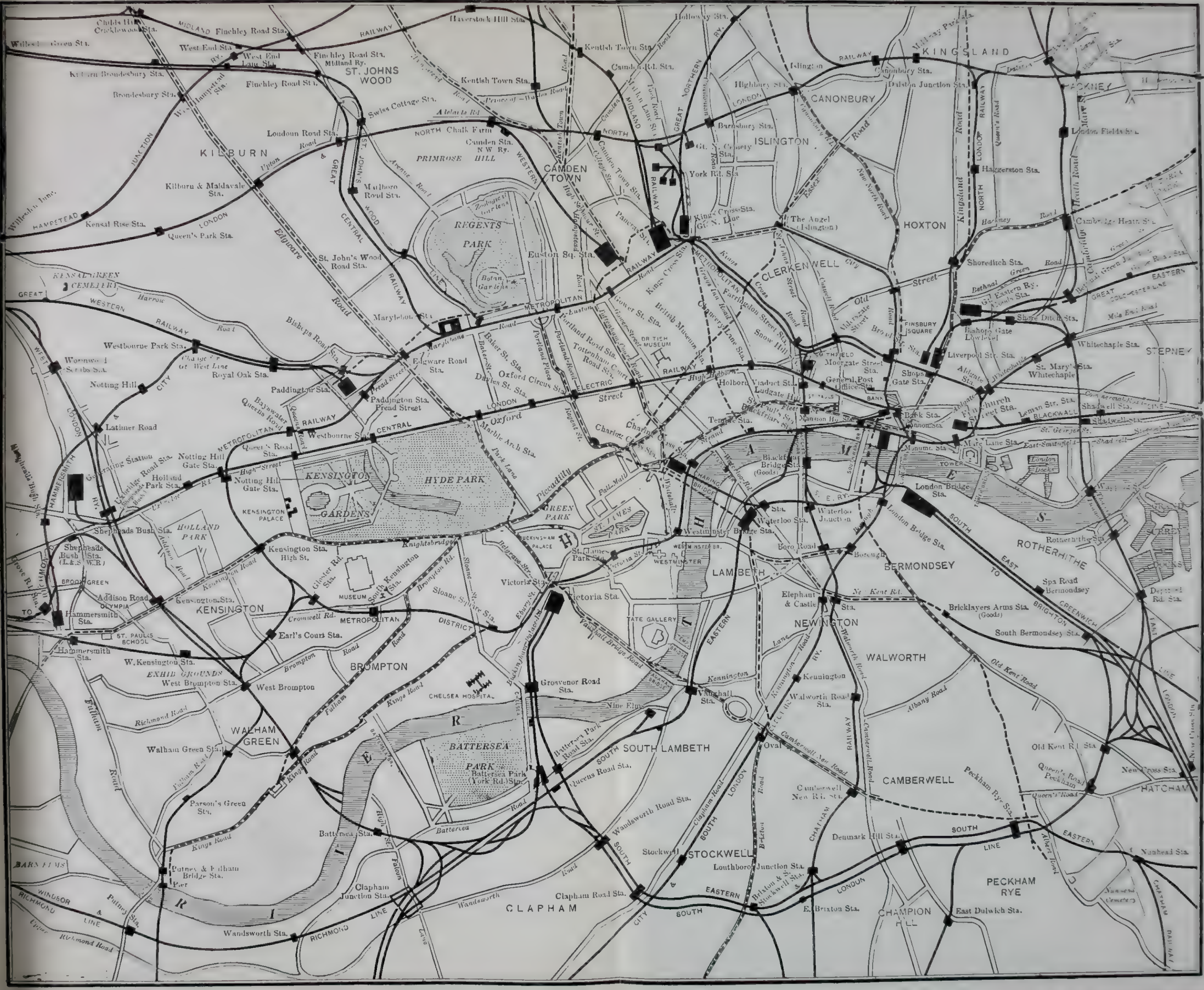
Such a scheme must be formulated with a full comprehension of the requirements of rapid transit, which is largely the problem of concentrating masses of people in the morning, and distributing them at night, as well as providing quick inter-communication. The existing steam-railway routes are the most natural and available channels for suburban distribution, but they must be supplemented by local railways in the City for general traffic, and by distributing lines outside.

An idea prevails that London conditions simply require transportation between certain centers of activity. This view must be discarded, isolation of districts destroyed, and London made a city whose people have a common interest, instead of an aggregation of parishes each with local ambitions and responsibilities.

Rapid transit can be had only on reserved rights of way, and be provided by systems which shall offer sufficient return to warrant the construction of new roads, or the supplying of new and suitable equipments on existing railways, whether operated singly or as a part of a general system. Multiplicity of roads, independently promoted, run on limited and oftentimes competitive routes, forming no part of a well-ordered plan, and operated under separate managements, will add to, not solve, the difficulties of the rapid-transit problem.

Every underground railway in London should be operated by a single local corporation, with concentration of management and undivided responsibility, aided by the most advanced methods of equipment and transportation. They should form a network gridironing London, connecting all important centers, the intersections, although at different levels, having common stations, except in the City, and in close contact with the stations of the existing suburban railways. Such a system can, by proper Parliamentary authority, be created by the absorption and harmonizing of the best parts of authorized roads, and the addition of such others as will accomplish the required object without unnecessary duplication of tracks and routes. The general plan having been determined upon, as was recently done in Paris, construction could proceed upon the more important lines, and the less important or new sections be added later.

With well-chosen routes, perpetual franchises, and absence of additional competition, capital will be more readily forthcoming for such a system than it will for an aggregation of independent roads. Since, however, the problem is one vitally concerning all London, it would be preferable to have construction authorized under some plan of municipal help and co-operation, similar to that characterizing the new rapid-transit road in New York, to insure rapid construction, least first cost, and lowest fixed charges. In the accompanying map are indicated some crude suggestions of such a system, which lends itself to flexibility and efficiency of operation and ease of transfer from one branch of the system to another, as well as to connections with existing local and suburban railways. It comprises, with the extensions outside the limits of the map, about 50 miles of line, and could probably be constructed and equipped for less than twenty millions sterling.



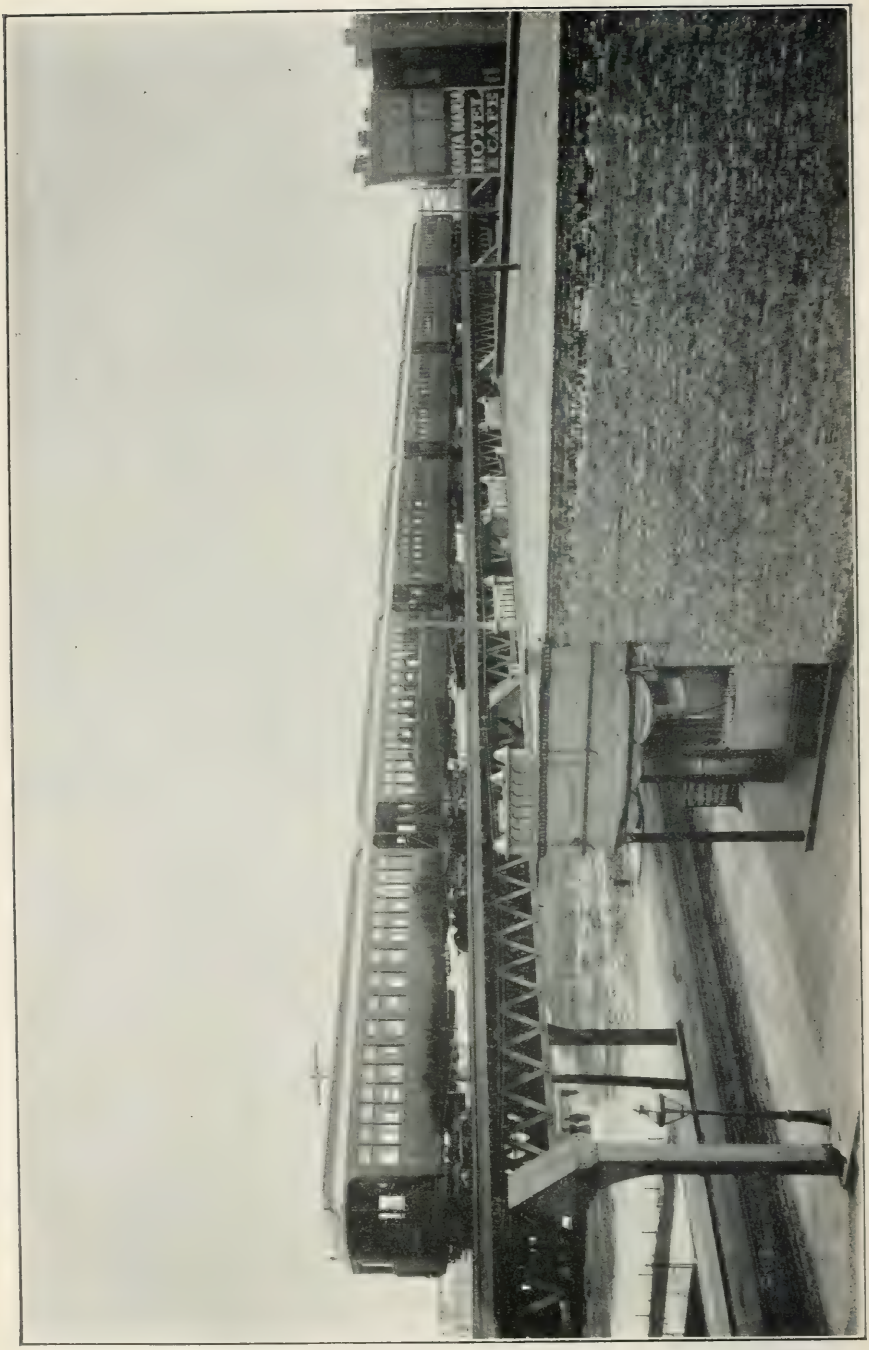
MAP OF LONDON, SHOWING IN SOLID LINES THE [illegible] RAILWAYS AND IN BROKEN LINES THE [illegible]

Operation of such a system must be accompanied by radical departures from English steam railway methods. There should be an abolition of classes and differential fares, as well as of the present type of cars. No road operating for internal and short local traffic is justified in having class distinctions; they might as well be made in the waiting stations and platforms, or in the lifts. The experience of the existing deep-level roads, as well as of all American railways of like character, confirms this view. With the abolition of classes will disappear any practical reason for differential fares, for they can be set at a fair price for the mean distance traveled, and when so determined return tickets are unnecessary. As a concession to workmen's necessities, a reduced fare may be permissible and advisable at certain hours of the morning and evening, at which times also trains will run very full. For other hours tickets can be sold in bulk at some reduction, for the possession of tickets tends to increase traffic at intermediate hours. On almost all branches there should be free exchange at common stations, save in those cases where it might be necessary to divert or restrict travel, as is done on the Metropolitan Railway of New York, and on the elevated and surface lines in Boston.

MULTIPLE-UNIT TRAIN, WESTERN RAILWAY OF FRANCE.

The compartment car is unsuited to traffic of this character. While easy to unload, it is not as quickly loaded in practice as the corridor type with free access from one car to another. If train lengths are made to vary with traffic demands, such a car will load and unload more quickly and will run more evenly filled than the compartment type.

Much has been said about confluent conjunctions, through traffic,



MULTIPLE-UNIT TRAIN, SOUTH SIDE ELEVATED RAILWAY, CHICAGO.

and loops. Grade crossings should, of course, be prohibited, and junctions other than end-on ones should be made only where Y's are required to get necessary car movements, or where trains can be safely diverted. Most branches should be operated on the shuttle principle, and loops even avoided unless they are of considerable size and take in new territory with two or more stations. Where common stations are impracticable, the separate stations should be connected by sub-ways, as is so well done at the City ends of the present deep-level roads.

That electricity shall be the motive power for any rapid-transit road needs no argument. How it shall be applied on roads with congested traffic should be logically apparent, although there is a more or less current notion that the ills of some railways can be cured simply by the adoption of electricity, irrespective of management, conditions, or methods, and that the crowded condition of others can only be relieved by the construction of parallel lines either overhead or underground. Both conceptions are erroneous. The underground roads are competitive with surface facilities, and where there is competition that route will command the most passengers which can offer the easiest access, the greatest convenience and comfort, the lowest fares, and the

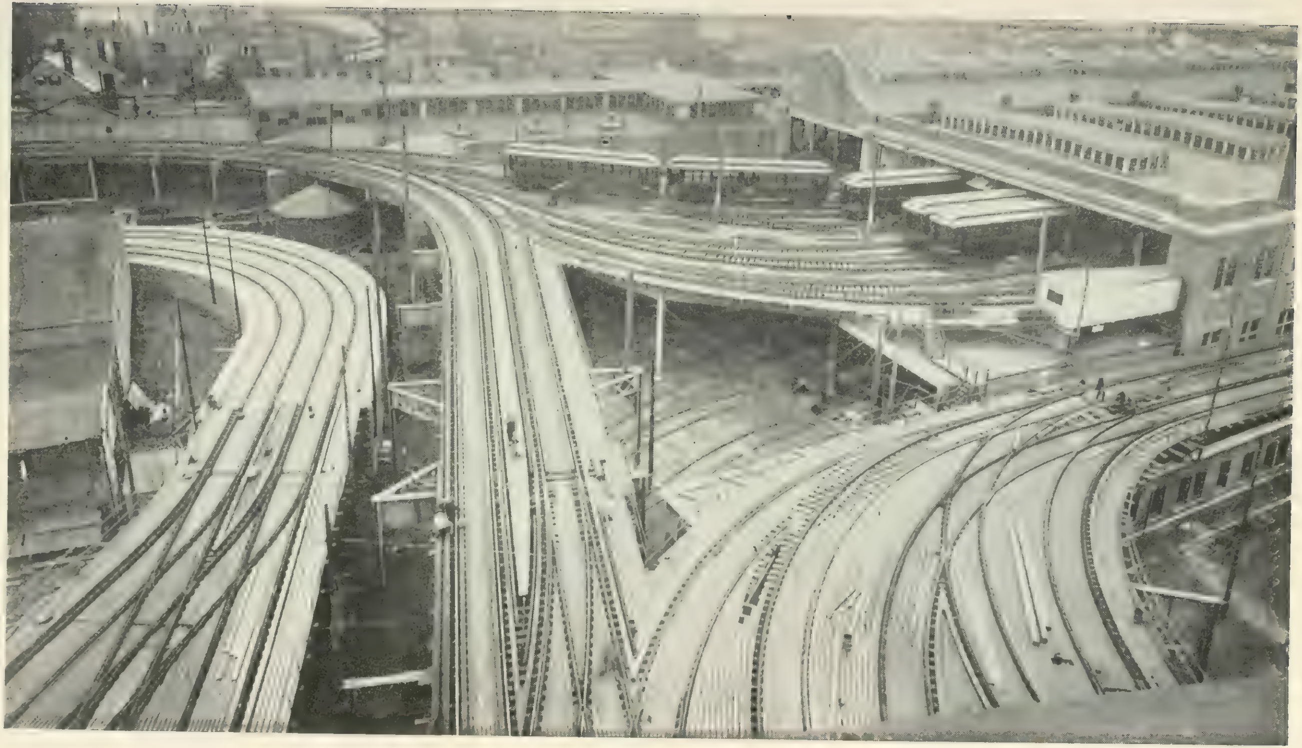
LEADING END OF NINE-CAR MULTIPLE-UNIT TRAIN ON THE WESTERN RAILWAY OF FRANCE.

most frequent and rapid service. The latter can be had only by a special application of electricity.

A railroad consists of two parts: first, the stations, tunnel, permanent way and rolling stock; and second, its motive-power equipment. The initial cost of all that is included under the first, which may be considered "dead" equipment, varies from about £400,000 per mile of line (double tunnel), on the tubular railways, to nearly £1,000,000 per mile on a part of the older tunnels. All the roads normally provide for only two tracks with the necessary sidings and cross-overs. The tremendous cost of this part of any road which can be constructed in London prohibits general consideration of the duplication of tracks on roads which depend upon local traffic. It is advisable and necessary, therefore, to make the greatest use of the unavoidably large fixed investment by the adoption of a type of electrical equipment which shall permit of any increase of traffic up to the physical limitations of the road.

MULTIPLE-UNIT TRAIN, BOSTON ELEVATED RAILWAY.
Showing station building, grade, and curve.

Railroading is, after all, the problem of getting traffic, and transporting all that can be got quickly and safely at a minimum cost. Oftentimes, from an over-zealous regard for operating expenses, a manager loses sight of what induces travel. There are two classes of traffic—one forced, and the other coaxed. The latter is generally needed to fill trains at light hours, and is competitive. The most



SULLIVAN SQUARE TERMINAL YARDS AND SHOPS, BOSTON (MASS.) ELEVATED-RAILWAY SYSTEM.

cogent appeal to this class of passengers is promptness and speed of service, as well as comfort. The ideal service, so far as the passenger alone is concerned, would be by single cars operated at high speeds, and following each other at the shortest possible intervals. The conditions of tunnel service, however, and the heavy character of the traffic at certain hours prohibit this ideal condition. So there must be, to get the most practical results, an expansion of the car into a train varying in length according to the time of day, and a lengthening of intervals to meet the requirements of operation at high speed.

High speed requires large power, this depending on the frequency of stops and the character of grades and curves. To utilize it there must be a high percentage of weight on the drivers. This weight may be especially created, as with a locomotive or locomotive car, or it may be provided largely by the car-bodies and passengers, as on an ordinary tramway, where all or nearly all the weight is on the drivers.

These requirements and the consideration of many practical features of railroading in handling frequent trains and a congested service have led to a natural and logical development in modern electric traction, now generally known as the "multiple-unit system." This is a method of train operation and control by means of which cars are equipped with motors and motor-controllers individual to these cars, so that they may be united with any number of other cars similarly equipped, or with any number which have no motors, into a train of any length, and operated from as many points as desired through a controlling line common to all cars. The number of the cars, their sequence, and their end-to-end relation are preferably matters of indifference. The character and capacity of the equipment is dependent upon the schedule required; it varies from every car, where the highest schedule is required, down to two cars in a train. Every motor car is a unit, and any combination of motor cars and trail cars may also be considered a unit, which can be operated from either end, and can be joined with other units.

Such a system readily lends itself to every condition of congested service. The similarity of equipment insures flexibility of train operation, and provides a motive power proportioned to the requirements. Locomotive switching operations are abolished, trains can be reversed at any cross-over, and traffic concentrated on any section of a road. The safe interval between trains is dependent upon the maximum speed and the power of control, and hence both the time and the distance intervals between trains can be reduced. A motorman will approach a station with more confidence, and under closer headway, when

MULTIPLE-UNIT TRAIN, BROOKLYN ELEVATED RAILWAY.

his maximum speeds are low and the braking distance traveled short, and when he has confidence that the train ahead, once started, will promptly get away. With high-powered equipments any required schedule up to the maximum becomes possible, and with any given mileage the number of cars in service can be made a minimum. Where a crowded system has main tracks with branches, units for the different branches can be combined on the main line, and split up at junctions, and *vice versa.*

The operation of the multiple-unit system is the simplest. Every unit being self-contained, and every aggregation of such being, so far as the motorman is concerned, simply an extension in the length of the unit without in any manner changing its character, operation becomes habit. Like hand-and like train movements exist whatever the combination of units. Protected by automatic features, a man of even limited intelligence can handle trains with less trouble, so far as the electrical apparatus is concerned, and with less instruction than is required for the air brake, for apparatus is now actually built on the plan of making it "fool-proof and fire-proof." The highest safety being essential, the system of operation obviously provides it. In case of failure of brakes, or on slippery rails, the machines throughout the entire train can be safely reversed. The current input to the machines is automatically limited on each one to its safe capacity. In case an accident should happen to an operator, the entire power is instantly removed from the train, and in case the master switch on the leading car becomes disabled the train can be operated from either end of any other car. In fogs and on slippery rails, a fixed schedule can be maintained more effectively because of the lower maximum speed and the less distance traveled in braking.

Although no regular testimony was taken before the Parliamentary committee on the subject of train equipment, many of the advantages stated were so apparent that, reinforced by the facts concerning the operation of the Chicago South Side Elevated Railway, where the multiple-unit system was first put into public operation by the writer, and by those relating to other roads since equipped, the system practically received the endorsement of that committee, a fact which may have a potent and far-reaching influence.

TWO-CAR MULTIPLE-UNIT TRAIN ON THE BOSTON ELEVATED RAILWAY.

The system also has the endorsement of proved commercial success. Within four years it has been put in operation on, or contracts have been closed for, over two thousand one hundred full-sized railway cars, requiring equipments aggregating 275,000 horse power, or more than is on all the electric railways of any character in Great Britain, and its adoption is already determined for at least seven hundred cars more, requiring 100,000 horse power.

In practice, train lengths vary from two to nine cars, and equipments from an average of 100 to 300 horse power per car, the latter characterizing the Boston, Mass., Elevated Railway, the latest road equipped. This is the most difficult and the highest-powered regular railway in existence, and operates the heaviest passenger service per mile and per car. It has descending grades of one in twelve, ascending grades of one in twenty, a succession of sharp and reversed curves, a possibility of twenty routes in 7 miles of line, and every car on every train is equipped with two 150-horse-power motors. It opened June 10, 1901, carrying 300,000 people with but sixty-six cars in operation, it has since regularly carried 200,000 people with ninety cars in service, and within a month after opening it has been found necessary to increase its equipment from one hundred to one hundred and fifty cars.

Roads of standard clearance permit of the fullest application of this system, although on the Metropolitan and District Railways the requirements of even an excellent schedule demand the equipment of only half of the cars with two motors of proper size each. Any road of tubular construction having 13 feet diameter likewise permits of the application of the system to any extent. Where the diameter is only 11 feet 6 inches, however, as on some of the roads built or projected, then there can be but limited equipments. These roads are built with accelerating and braking gradients, so that good schedules require but two motors on half the cars. By having trains made up of two three-car, or two four-car units, the first and last car of each unit being equipped with two motors, a special construction of car under even these limited dimensions becomes possible. On such equipments the best practice is to cut the trains in two for the lighter hours of service, and to maintain a high frequency, alternate trains being sent unbroken into the yards.

With tunnels of the proper size, it is evident that on the multiple-unit plan a general system can be operated with the minimum of equipment and the most economical distribution of cars, trains can be made of varying lengths on different sections and branches to best accommodate traffic and to prevent massing of passengers, and they can be handled in the most expeditious and efficient manner with the minimum of trackage.

Space permits only limited reference to the suburban steam lines, which, however, are vital factors in the general problem, and which as yet have no realization of the disastrous effects of a live trolley competition. At certain hours of the day some of these have already nearly reached the limit of expansion by steam operation on existing tracks, and are seriously considering adding to their facilities by construction of tunnels for their suburban lines. Such construction is at present utterly unnecessary, and if these roads should operate their suburban traffic electrically, the trains at times of heaviest traffic being made up of two or three units, each having power enough to operate it at a proper schedule, the capacity of these roads could be very largely increased. On many of them there are from eleven to thirteen cars in a train, even at times of light traffic, when the trains are often an hour apart. With station distances averaging 1¼ miles, the schedule speed is sometimes as low as 13 miles per hour. On such roads the train movements can not only be greatly increased at busy hours, but a traffic can be created at other hours by offering superior facilities in higher speeds, more frequent trains, and prompt connections with local feeders, which, quite apart from any economies of operation, would insure a large return on the cost of an electrical equipment.

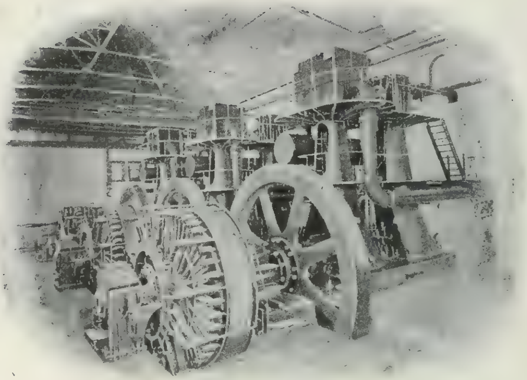
Briefly summarizing then, rapid transit in London and its suburbs depends upon a wide-spread and radical application of electricity, and this is of even more importance than the creation of new tunnels. The latter should be built according to well-matured plans, under a central authority, and form a network following main arteries of traffic and connecting busy centers with other centers, and with outlying districts and suburban stations. The roads should form part of a general system, under a single management and responsibility. Classes should be abolished, one regular rate of fare established, with workmen's fares in limited hours, and there should be free exchange except on limited routes, or within two zones. Locomotive practice should be abolished, and trains operated in small units which could be combined at will. Electric trams should be provided in place of many of the 'bus lines on crowded streets, and radiate from every terminus of tubular railways and from most of the suburban stations. Every steam railway should equip at least its suburban service with electricity on a plan which permits of variable train lengths, plural control, high schedule speeds, and the maximum use of existing trackage.

The electric railway has become a modern necessity, and the greatest of philanthropic agents. It is a distributor of the masses, and the most effective agent in solving the housing problems of a metropolis. Every minute taken from the time of transit to and from business is a minute added to the fireside and home. Every increase of speed adds to available dwelling space, increases taxable areas, augments traffic, and betters the *morale* of the people. The days of doubt and hesitation have long passed. Within thirteen years, in the United States

LEADING END OF MULTIPLE-UNIT TRAIN, BOSTON ELEVATED RAILWAY.

alone, electricity has been adopted on more miles of street, elevated, and suburban track, replacing horse, cable, and steam equipments, than there are miles of steam railway in Great Britain. It needs but a practical survey of all that has been accomplished in this connection to realize the immense benefits possible by an intelligent adoption of electric propulsion.

Last, and not least of considerations at a time when there has been a universal reduction of dividends on English railways, there will be found in a suitable electric application a remedy for many existing ills, and others to come as tramway competition begins to be seriously felt. When English capitalists and transportation managers wake up to the possibilities of electric traction, concerning which there is no longer room for question, there will be a movement whose far-reaching character can at present only be slightly realized, and to which the English traveling public will heartily respond.



THE STANDARDIZATION OF ELECTRICAL APPARATUS.

By J. T. Broderick.

In the following article, Mr. Broderick takes up the discussion of the important opportunities for economy presented by present conditions in the electrical manufacturing trade. The comparative youth of the industry is sufficient explanation of its lack of settled standards; but much of the diversity of detail, dimension, and pattern might be simplified, to the great advantage of both manufacturer and consumer. In this paper the view-point taken is that of the maker. A sequel will show how the user's interests are concerned.—THE EDITORS.

THE standardization of electrical apparatus was carefully considered about two years ago by the American Institute of Electrical Engineers, and preferred potentials and frequencies, as well as methods of dealing with the questions of efficiency, temperature, and insulation, were adopted. The subject, however, is one which concerns not alone the electrical engineer; it is of vital importance to the manufacturer of electrical apparatus, to the mill or mine owner, to the local company producing light and power, and to the public generally. In the following pages it is treated mainly from the standpoint of the manufacturer.

A manufacturer, to be successful, must produce apparatus which is economically designed, which can be supplied when it is wanted, and which will do the work required of it in a satisfactory manner. In other words, cost, delivery, and quality are the primary factors with which he must deal; and in dealing with these factors standardization must of necessity engage his attention.

In order that whatever is said concerning the cost factor may be wholly intelligible to those unfamiliar with accounts, a brief explanation of how costs are made is perhaps required at the outset. Different methods of calculating costs are employed by different manufacturers; but whatever the method employed, consideration must always be given to three main elements—material, labor, and operating expense. The expenses for material and labor required in the construction of a given machine are easily determined under any thorough system of accounting. The operating expense, which is as much a part of cost as the expense for material or the expense for labor, is usually obtained by means of a percentage added either to the charge for labor or to the total charges for labor and material. The sum of the charges for labor and material and the charge for operating expense, obtained in the manner described, constitutes cost.

The utmost pains are taken in all reputable manufacturing organizations to insure accuracy in this cost; but considering it with reference to any individual machine or appliance, it will be seen that it is a computed cost rather than an absolute one. It would be impossible, with any reasonably simple and economical system of accounting, to apportion the operating expense with strict accuracy over the many types, and the many modifications of these types, which must be handled by even the smallest concern making electrical apparatus.

No manufacturer, therefore, can determine with exactness the effect of needless differentiation and specialization on the cost of his product. Broadly speaking, it is evident that when apparatus is built in large quantities its cost is less than when built in small quantities, and that modifications, not in the direction of improvements in design, increase the cost of apparatus built in either large or small quantities. It is further evident that apparatus which must be newly designed throughout costs more than that which has been developed, the difference in cost, of course, being greater when the developed apparatus is made in large quantities than when it is made in small quantities. A general idea of what specialization means, from the view-point of the manufacturer, may be obtained by an analysis of certain differences in the cost of producing standard and special apparatus.

Assuming the highest practicable degree of productive economy attained in the case of standard machines made in large quantities, and assuming further that in such case the absolute cost of a given machine is $100, it may be said that the absolute cost of a special machine is increased over and above this amount, because of its being special, for the following reasons:—

First, the cost of the investment required in connection with the manufacture of a special machine is greater and the investment is utilized at a much lower degree of economy. More floor space is required, and the space allotted is needed for a longer period. Special tool fixtures, such as jigs, blocks, cutters, and boring bars, may be needed; or, if standard fixtures are employed, in adapting them for service on special parts they are destroyed or their efficiency for service on standard work is impaired. It is easy to see how specialization affects the economy of tools by conceiving of a machine-shop installation consisting of a milling machine, a drill press, a boring machine, and a grinding machine. These four tools, we will say, are to-day employed on standard work, each one performing its peculiar operation, the drill press taking the work from the milling machine, the boring machine taking it from the drill press, and the grinding machine taking it from the boring machine, with clock-work regularity and continuity and at the highest attainable degree of economy. To-morrow some operation in connection with the manufacture of a special generator or motor requires to be performed. Numerous letters and telegrams have been received urging that its delivery be hastened and that, if necessary, it be given the right of way in production. The drill press, in the group of four machines just described, happens to be the most suitable tool in the plant with which to perform the work; there is nothing to do but to utilize it, and, as a consequence, the milling machine, the boring machine, and the grinding machine, are temporarily thrown out of service. To avoid such a condition, spare facilities for emergency purposes must be provided or overtime work done with the drill press. Either method involves extra expense. No practicable plan has ever been devised by which the extra expense incurred by reason of the additional investment, of the destruction of fixtures or their impairment for use on standard work, and of the reduced efficiency in the utilization of tools, can be wholly included in the cost of a given piece of special apparatus.

Second, the direct labor cost of a special machine is bound to be considerably higher than that of a standard machine. The utmost care being required, this labor must necessarily be done by the most skilful and best paid mechanics and frequently by the day-rate method, which has been found from experience to be considerably less economical than piece work. A greater amount of labor is also entailed, the tools employed requiring to be dismantled, either wholly or in part, and provided with fixtures suitable for the special work to be done.

Third, the loss due to waste of material is greater in connection with the manufacture of a special machine. The raw material entering into the construction of a standard machine may be ordered ahead in large quantities and taken from the stock room in the shapes and sizes in which it is used. The raw material entering into the construction of a special machine must either be specially ordered or made up from stock on hand. When it is specially ordered a surplus may be secured. as an insurance against spoiled work, and in most cases no use can be made of this surplus and it becomes necessary sooner or later to dispose of it as scrap. Making up the parts required from available stock is an expensive process. For example, a generator shaft of odd shape and dimensions may be needed. To secure this shaft it may be necessary to take from stock a larger shaft and machine it to the shape and dimensions required, thus wasting a certain amount of material.

Fourth, a special machine requires a greater amount of general or operating expense in connection with its manufacture than a standard machine. Vastly more superintendence and clerical labor are needed in the shop, and there is an inevitable consumption of a certain amount of the time of every one concerned, from the executive officer or manager, who must express an opinion or pass judgment on the many doubtful points that are sure to arise, to the messenger who carries the written instructions or information from place to place. The expenses for testing are also likely to be greater, tests of longer duration and greater variety often being essential in order to satisfy the designer that the exceptional guarantees specified have been fulfilled and that the machine will operate satisfactorily. In addition, more expense is incurred in preparing a special machine for shipment. Extra quantities of packing material and lumber are frequently necessary, and extra supervision and labor are required in packing and boxing and, in the case of large apparatus, in loading the apparatus on cars and providing it with suitable supports.

It may be assumed that, inasmuch as the charges for both labor and material are greater in the case of a special machine, and the percentage for general expense is added either to the charge for labor or to the sum of the charges for labor and material, as already explained, the extra general expense is taken care of automatically. It will be seen, by bearing in mind the effect which special apparatus has on the cost of standard apparatus, that this can be only partially true. As already shown, it is impossible to apportion general expense with strict accuracy over the many types and the many modifications of these types with which manufacturers of electrical apparatus must deal. A percentage must be employed; and it is therefore evident that without a system of accounting so elaborate that in itself it would be most uneconomical, the cost of standard apparatus must be burdened with a portion of the extra general expense incident to the manufacture of special apparatus. Hence, an increase in the proportion of special apparatus must either increase the cost of standard apparatus or prevent reductions in its cost.

It will be seen that thus far the increased expenses incurred in the ordinary channels of production only have been considered.

It is customary with some manufacturers to report with the cost of special apparatus, as development, the expense incurred for special tools, for patterns, for draughting, and for engineering. The amount thus reported for a given article, however, by no means represents the entire expense incident to the development of that article; it represents only the amount which it is practicable to apportion. Special apparatus demands the highest engineering skill and the ablest supervision in the draughting, pattern, and special-tool departments, and swells the operating expense far out of proportion to the output secured.

The differences above indicated show incidentally why the computed cost of special apparatus must be greater than that of standard apparatus. It should be borne in mind, however, that they are set forth primarily as the differences affecting the absolute cost of both standard and special apparatus: and the conclusions to be drawn from their analysis are:—first, that under any practicable system of accounting only a portion of the operating expense incident to the making of a special article is borne by that article, the remainder swelling the cost of standard apparatus; and second, that only a portion of the expense for engineering and draughting incident to the development of a given special article can be reported with the cost of that article, the remainder still further swelling the cost of standard apparatus.

It needs but a moment's consideration of the differences affecting costs to see the connection between standardization and deliveries. The uncertainties as to the design and manufacture of special apparatus, and as to the time required to secure raw material, make it extremely difficult to give satisfactory promises of delivery before orders for such apparatus are placed, and after promises which appear to be safe are given, and orders are secured, extensions may be found necessary because of the unforeseen contingencies that constantly arise in the designing, manufacturing, and testing stages, and of delays in obtaining raw material. Nor is this the only aspect of the delivery question which must be kept in mind and dealt with by the manufacturer. As illustrated by the case of the four machine-shop tools already cited special apparatus encroaches both directly and indirectly upon the facilities needed to produce standard apparatus, thereby interfering with the prompt execution of orders for such apparatus.

The differences affecting costs also indicate how important a bearing standardization must have upon quality. An unusual accumulation of orders for special apparatus, by making hurried work necessary, increases the liability of errors in design. It is evident that designing is a class of work which requires to be done in a deliberative manner or, at least, without that pressure which may sometimes be exerted, with advantage, on manual or clerical work of a duplicate character. Furthermore, the pressure exerted in the shop to meet required dates of delivery is apt to occasion faulty workmanship, the workmen, however skilful and conscientious, being placed at a disadvantage by their unfamiliarity with the methods employed to secure the new combinations called for. In addition to all this, with the time of his designers and mechanics taken up with special work, the manufacturer loses the benefit of that skill and vigilance which are needed to improve the quality of his standard product in order to lower its cost and increase its efficiency.

The annoyance and loss occasioned customers by inability to obtain apparatus when it is needed, or by delays in securing satisfactory operation due either to errors in design or faulty workmanship, are bound to injure the reputation of any manufacturer; and what is of more immedidate moment, they make collections difficult. Take, for example, a contract amounting to $10,000, of which $9,000 is for standard apparatus and $1,000 for special apparatus, the latter to be used in conjunction with the former. Payment under such a contract may be with-held for an entire year because of unavoidable delay in delivery or unsatisfactory operation of the special apparatus represented by $1,000, thus causing a direct loss of $600, the interest for one year at 6 per cent. on $10,000. Considering the extra expense and waste in the designing, manufacturing, and testing stages, as well as the loss on the deferred payment of $10,000, it is easy to see how the special apparatus might actually cost from 25 per cent. to 50 per cent. more than the amount received for it.

Possibly it will be inferred by some that, in so far as the problems occasioned by specialization bear upon delivery and quality, a simple solution is to be found in surplus facilities. Such an inference, however, can only be drawn by losing sight of a very practical phase of the subject. A manufacturer, in the management of his plant, must assume some reasonable ratio of capital invested and fixed expenditures to the total business to be done; otherwise most of the difficult and complex problems which confront him daily would disappear. Standardization is primarily an economic question, and in its treatment it is necessary to be guided by simple economic laws. Where these laws can be disregarded specialization need be limited only by fancy.

The benefits accruing to the local company by the use of standard rather than special apparatus are immediate and tangible. Quicker deliveries are secured, the investment outlay is less, satisfactory operation is more likely to be insured, and the cost of maintenance is lower by reason of the readiness and cheapness with which renewal parts can be secured. In short, special apparatus, though it be designed by the ablest engineers and built by the most skilful workmen, places the local company at a disadvantage in starting its plant and taxes its resources forever afterward. So far as standardization goes, the interests of the local company and those of the manufacturer must, in the nature of the case, be identical. And it naturally follows that whatever is for the best interests of the local company and the manufacturer is, in the long run, for the best interests of the public. Prices, on the average, are regulated by cost; this result is brought about either by competition or by other forces which it would be beyond the scope of this article to consider. And if, therefore, as the facts presented indicate, the standardization of electrical apparatus tends to lower costs, it is bound to be beneficial to everyone who uses electric light or rides on a car propelled by electric power.

Considered with respect not only to electrical apparatus but to machinery in general, there is nothing in standardization that need alarm those who, broadly speaking, believe in the full and free exercise of individual taste. In the design of machinery intended to do work rather than to please the eye, while neatness and compactness may be essential, wholesale differentiation is surely not called for. The ordinary man, in selecting the cloth for his coat or the style of architecture for his dwelling, wishing to have ample scope afforded for his fancy, demands variety; but in buying a lathe or an electric motor for his machine shop, æsthetic considerations are of secondary importance, his chief aim being to obtain, with the least outlay, that which will best do the work required of it.

THE PROPER DISTRIBUTION OF ESTABLISHMENT CHARGES.

By A. Hamilton Church.

IV.—THE CLASSIFICATION AND DISSECTION OF SHOP CHARGES.

Mr. Church's first article, which appeared in our July issue, dealt with the vital necessity of accurate cost keeping. His second paper analysed the chief accepted methods of apportioning general expense to individual jobs and pointed out their deficiencies, and in the third article he developed a comprehensive and accurate system. His next paper will take up the application of his system to mass production.—The Editors.

IN the preceding articles the practical effects of the new method have been developed, special stress being laid on the desirability of discriminating in regard to the incidence of charges, rather than seeking, as has hitherto been the practice, to throw all classes of charge into one common collection of shop expenditure, and then to average down the whole per unit of time or wages.

It might be supposed that the steps necessary to do this were very difficult and cumbrous. This is not the case, unless indeed at the outset. Once roughed out and the various factors determined, the subsequent steps present no special difficulty. It will be useful to bear always in mind the illustration already given of the "little shops," forming part of a large mill and rented out to weekly or monthly tenants. If we follow the lines that would of necessity be followed by a landlord of such a building in order to the fair proportionment of rents, we shall not be far out of our course.

The first item to be dealt with would probably be the building. For the sake of simplicity, we may assume that this is of one storey only. There is, of course, no difference in principle whether the building be one of several storeys high. As a matter of fact this method was first worked out for and applied to a factory which consisted of two parts, one being an old building of five storeys, and the other a modern shop of three. The process is the same in any case. All the factors of capital and revenue incident on such building are carefully mapped out. The capital invested in land has first place. To this is added the cost of the building. Particular care is taken to consider whether any inequalities in cost in the various parts of the latter are significant or accidental—that is, whether they have any special reference to the *uses* of that part. Having exhausted the capital items, they are reduced to floor areas. That is to say, every square foot of floor space not subject to special conditions is considered as representing so much capital outlay. Having determined this, the charges incident on the floor space due to this capital outlay are ascertained, then interest, ground rent if any, taxes, insurance, depreciation of buildings—all are reduced to figures, and therefore to so many pounds or dollars per square foot of floor area. The first cost and working expenses of heating and ventilating appliances are treated on a similar footing.

When this is finished, with any factors peculiar to the local circumstances taken to account, we have obtained a pretty close idea of what rent charge is due to a production centre occupying say 13 square feet of working space. Whether we are determining the figures for the purposes of subletting our building or for determining the correct incidence of such items of expense in a large shop, makes no difference whatever to the process or its result. So many square feet of floor, so many dollars per annum out of pocket. If machine A occupies twice the space of machine B, it is costing us just twice as much to house it. There seems to be no escape from or alternative to this position.

Where shops are electrically lighted by overhead lights, the cost of this also is reduced to a floor-area basis. The items include:—Charges due to the capital sunk in leads, switches, lamps, and in some cases where the light is generated on the premises, a due proportion of the cost of the generating plant; interest, insurance, and depreciation is taken out on these sums, and to the result is added the actual cost of power or current, carbons, cleaning, and so forth. Here again we get a rent representing the cost of lighting either one of our little shops or a given area of a large shop.

Two items are thus complete—first, a rent for the empty shop or area, second, the rent of the same lighted up. The shop is, in fact, ready for occupation and use.

Probably the cost of power will be the next item dealt with. This is a more complex subject, still not insuperably so. The capital outlay on engines, boilers, motors and generators, main shafting, and pulleys being ascertained, and the resulting revenue charge therefrom, to this is added the running expenses—fuel, stoking, repairs, and so forth, reduced to a value per horse-power hour. There is not much difficulty in the broad working out of this figure, but the position of shops and various local details make the problem a little troublesome. In some cases the cost of power might not be the same in all parts of a large mill or scattered group of shops. This is a matter of which the practical aspect will vary, and no definite rulings are possible. It is evident that in many cases the charge for power should not be averaged. The cost of transmitting power to a distant shop might sometimes give rise later to the adoption of more efficient means of transmission, and this should of course show in the charges of that particular shop alone, and not reduce the average cost of power in other places which have nothing to do with the improvement. In most cases, however, the average charge per horse-power hour would meet the case fully.

The shops are now ready for the introduction of machines.

The charge due to interest, depreciation, and insurance on the value of machines is of course the item which the new method has in common with the ordinary machine-rate plan. These charges are calculated per annum and then reduced to a rate per hour, based on the probable number of hours the machine will be in work under normal conditions. Thus, if we take the annual work of any machine to be 2,500 hours, and the annual charge for interest, depreciation, and insurance to be $150, this gives an hourly rate for these items of 6 cents. The ordinary machine rate being extensively understood at the present day, this particular item need not detain us farther. It should be noted, however, that the items of annual or hourly charge for interest, depreciation, and insurance do not form the whole machine rate as on the old method, but are but one of many factors, of which several have already been described. The new method includes all that was signified by the old machine rate, and several other items as well.

It should be mentioned that along with each machine are included countershafts, fencing, belting, or motors, which are specially used to operate that machine alone. Some care is necessary to discriminate between what may belong to individual machines and what pertains more properly to the main system of power transmission.

In addition to the empty shop lighted and heated, with its necessary main system of power, we have now considered the machines installed and ready for working. It will be evident that up to this point the charge incident on the work done on any machine will be made up of :— (1), a rent charge for the space occupied ; (2), a charge for the capital sunk in the machine itself ; and (3), a charge for power calculated according to the average amount used by the machine. None of these items can be imagined as being other than properly connected with the particular work done on any given machine, or as having on the other hand any connection with work done on other machines, whether they happen to be fixed under the same roof or not. We have, in fact, not so much differentiated as kept separate these factors of production cost, which on the ordinary methods of averaging shop charges are jumbled up in one common account.

There remain, however, other items perhaps not so definite, but yet capable of being worked out into reasonable approximations to the truth. Of these are the costs of overlooking and supervision, which are frequently special to a limited group of machines, as, for example, in the case of a sub-foreman in charge of a half-a-dozen screw-making machines or turret lathes. The approximate cost of such supervision for a year can be taken, divided by the number of machines, and reduced to an hourly rate per machine. The importance of confining a special charge of this kind to just that class of work that incurs it, instead of letting it become part of a general shop charge and thus become spread over all the work of the shop, will be clear. The same result might, of course, be attained by a very elaborate system of allocating such overlookers' time on a cost sheet, but this would be much more troublesome and not appreciably more accurate than the plan proposed. It would be, in fact, *less* accurate, as will be seen when the question of partially-idle groups of machines is considered in the article on mass production.

The cost of tools may in some special cases be similarly treated, as for example the wheels on emery machines, cutters on milling machines, etc. This requires very cautious treatment. The same remark applies to charges for oil, or other material such as rouge, used in particular processes. Such materials frequently form a very serious item in the true cost of a process, and the justice of including them in the working expenses of a production centre will be felt if the case of the separate little shops is considered. The expenses of such a little shop doing polishing work by means of a buff wheel will be readily allowed to be made up of the standing charges already detailed plus the value of actual emery flour, rouge, etc., consumed on the work. And that substantial accuracy is attained by reducing such item of expense to a charge per working hour will be admitted if we assume, as we are entitled to, that the same machine employed on the same class of work uses approximately in proportion to the amount of work got through. If from the evident circumstances of the case this were not so, then other arrangements would be necessary. The rate might, for example, be higher when engaged on one class of work than for another. It has already been stated that an item of this class requires very careful consideration.

The principal items of shop expenditure are now accounted for. Those remaining comprise the wages of general foremen, and the cost of repairs done to the buildings, to power, transmitting, lighting, and heating plant, and to the machines themselves. This latter question, being mixed up with that of depreciation, needs some discussion.

The usual view taken of a depreciation rate is that it is a fixed percentage, say five per cent., on a gradually lessening value. The effect of this is to transfer the cost of a machine from the plant account at the outset of its career to the depreciation fund at the end of its life. The value of the machine, if plotted graphically, would show a series of intermediate values year by year, each rather less than that of the previous year. From a financial point of view this is correct. As the machine wears out its value as an asset decreases, and the provision for its renewal in the depreciation account increases. It is usually understood that the cost of minor repairs during working life is being met out of revenue. Therefore such repairs are properly a shop charge. Repairs or alterations, on the other hand, which practically give the machine a new lease of life, should be charged to plant account, wholly or partially according to circumstances.

The question which interests us here is:—How should the cost of repairs which are met out of revenue be dealt with under the new method? It is evident that they can be either kept isolated from all others and in connection with the particular machine or item of plant that has incurred them, or else be treated as a really general shop charge, such as foreman's wages.

The principle of the new method being to keep all expenditure individualised, wherever it can be done, it follows that arrangements must be made to give the cost of repairs expression in the various rate factors which go to make up the total new machine rate.

As the charging of repairs is always an *ex post facto* transaction—that is, the work done by reason of which the repairs have become necesary cannot possibly be charged with them—it will serve the purpose if such repairs be averaged over half-yearly periods, though still kept confined to the actual machines involved. Thus, if the power plant has been overhauled, the rent charge for power may be correspondingly increased at the next half-yearly balance, until such extra and abnormal expenditure has been wiped out. Generally, therefore, it will be seen that an estimated figure for cost of repairs is included in the various factors of the new machine rate, and this estimated charge is subject to periodical revision, if on examination it is found to be too high or too low.

It may be objected here that we are here breaking away from actual figures, and entering the nebulous region of estimated charges, which it is the purpose of the modern methods of accounting to avoid. The answer is that the breaking away is only temporary, and that the cost of repairs is more properly averaged over a more or less extended period than borne by any particular month in which they may have happened to be executed. And when it is remembered that the alternative to this method of averaging is the throwing of the cost of such repairs into the general fund of shop repairs, and spreading it away over the work done in a given month, with which it has manifestly no proper connection, the propriety of the plan advocated will not be in doubt. By this means, the cost of repairs to a turret lathe, for example, is kept incident on the work of that turret lathe and no other; and as no particular item of the current work can by any possibility be imagined to bear properly the burden of such repairs, no substantial injustice is done by a temporary want of co-incidence between the actual rate of expenditure in repairs and the estimated rate. On the other hand, the individualising principle is kept intact, and this is the more important object to keep in view.

Necessarily, the estimate for repairs included in the new machine rates must be no hastily determined or fancy figure. Throughout this method the preliminary determinations must be most carefully made. If this is done, then their subsequent variation will be an easy and almost automatic matter. If we recur to the case of the little shops, the justice of the foregoing contentions will be more clearly seen. It is evident that the cost of repairs to any one machine are part of the expenses of the little shop it is in. But, again, it would not be correct to charge with the extra cost the work which happened to be done in a week or month in which such repairs were carried out. More substantial justice would be done by estimating in advance the probable expenditure, and including that in the hourly rate charged on the work. Then, if at the end of a six months' period it was found that this amount had been underestimated, the small amount representing the *difference* between what was actually spent and what was charged to jobs as an estimated figure would be adjusted by raising the rate slightly.

The question of repairs done to the power plant or to the buildings of the little shops seems to present more difficulties. It seems clear that the landlord could not charge more for power or for rent because he had just spent a certain sum in repairs, merely to keep up the efficiency. On reflection this will be seen to strengthen the case for the averaging method. For the reason why no more rent could be charged is that, in fixing the rent in the first instance, the probability of a certain expenditure for repairs was foreseen and allowed for. It was, in fact, averaged in advance. And any discrepancy, any failure to estimate correctly the probable cost of repairs would, in the landlord's case, come out of his profit. It would be a dead loss to him. In the case of a large shop, however, there being no item corresponding to the landlord's profit to fall back on, the recovery of this unforeseen expenditure from the shop is the only course open. It must be got rid of by becoming an expense chargeable to work, and this is done simply enough by raising the rent charge per floor area, in the case of repairs to buildings, or per horse-power hour, in the case of the power plant.

The treatment of all these items is thus identical, whether we are considering the little shops or a number of productive centres in a large shop. It will be necessary now to consider the case of those charges which have no parallel in the little shops, such as foremen's wages, which press equally on a number of productive centres.

As there is no natural line of cleavage herein, no reasonable presumption in favour of such items being connected with one productive centre more than with another, we are compelled to treat them as really belonging to the category of general or non-individual shop charges, and thus to distribute over the work as a whole, on the hourly-burden plan for preference. The principle of this method has already been explained, and there is nothing special in the treatment of these general items which differentiates them from the ordinary distribution of shop charges by hourly-burden. When all the machines or production centres are running full time, there is nothing in the shop-charges account to distribute but non-individual items. All the rest will have been already allocated to particular jobs by means of the new machine rates.

It is when this is the case that the differences between the present method and any previous one are seen at the full. Out of all the many items of expenditure which go to make up the ordinary shop-charges account, and which are usually lumped together and spread like a thin paste equally over all jobs in strict proportion to time occupied only, we find but one or two items, themselves of relatively small amount, remaining to be treated in this way. All the main items of expenditure have, by following the natural lines of action, been kept immediately connected with the machines and therefore with the jobs done on such machines, on which they are properly incident. The large and expensive machine bears its own burden; so does the small and cheap machine. Their vicinity in the same shop does not have the effect of altering each other's shop-charge incidence. The introduction of a special overlooker on a small group of machines does not send up the hourly burden, and thus affect the work of the whole shop; it is confined in its effect to the machines and their work on which the increased expenditure was actually incurred. Throughout the items of expenditure have been not so much individualised as *kept* individualised, and thus preserved from mutual interference—just as much as if they were actually as well as hypothetically incurred in separate little shops. It would be hard to argue that this is not a decided gain or that it is not worth the trouble involved, whatever that may be proved to be. If it is worth while attempting to connect establishment expenditure with work at all, it is certainly worth doing so in a way which closely represents actual facts.

Having thus considered in some detail the method of organising the shop charges on the new method, with the result that it is demonstrated that when all the productive centres are making full time the great bulk of shop expenditure finds its way to the actual jobs on which it has been incurred, it remains to show what happens when there is a large proportion of idle time in the shops. In such case, while the work actually going through will as before be charged with its due expense as hitherto, there will obviously remain at the end of the month a certain amount of undistributed charges, exactly proportional to the idle time of the various productive centres.

This balance, together with the really general (or non-individual) shop charges remains to be got rid of. This is effected by means of an hourly-burden rate. There are thus, under the new system, two rates which enter into the cost of each job; 1, the new machine rate, which remains the same whether the shop be busy or slack; and 2, the hourly-burden rate, which it is proposed to call the "supplementary rate," since by its aid we spread away all the residual charges, which would otherwise escape allotment. This rate necessarily rises when there is a large proportion of idle machines, and falls when idleness is at a minimum. The supplementary rate thus becomes a significant index to the commercial efficiency of the shop. It should be the aim of the authorities to keep this rate as low as possible. Its rise when work is plentiful will be a sign of the most automatic nature that something is going wrong.

It may occur to the reader that the more appropriate way of dealing with idle-machine time would be to distribute the unallotted machine-rate amounts, not as part of the general shop expense, but as a kind of supplementary machine rate, thus confining the effect of idleness to the particular machine in fault. This would certainly be the ideal method, but it is not practicable under ordinary circumstances; the reason being that if a machine were to work only one hour in a given month, all the burden of the other two-hundred-and-odd hours would be discharged on the unfortunate job done in that one hour. And worse still, if no work at all were done in the month the unallotted rate would either be lost altogether, or else thrown into the supplementary shop rate after all. We are obliged therefore, from motives of expediency, to look upon idle time as a kind of visitation of Providence which the whole shop ought to bear.

It is true, no doubt, that we do here depart from the parallel case of the little shops, which we have endeavoured to be guided by. In their case, the accumulated burden due to slack times would have to be borne by whatever work was done in the month, but then in the extreme case of an almost complete idleness for a long period, such as a month, it would probably be a case of bankruptcy for the little shop. This alternative, as in the former case of the landlord's profit, has no parallel in the case of a large shop embracing many productive centres. The shop as a whole properly comes to the rescue of the idle machine and shifts the unallotted burden on to its broader shoulders.

The full effect of the new method, as contrasted with the older averaging methods, such as either the percentage-on-wages or the hourly-burden plan, may be glanced at. Briefly, it may be said that in all three the whole of the charges incurred in the month is spread away over the work done in that month. But whilst in the two former the distribution is on an arbitrary basis, on the new method the greater bulk of the charges allocated to a job are really what has been incurred under the actual conditions. If these conditions are varied, then although the number of hours or the direct wages may still remain the same, the amount debited to the job for shop charges will not remain the same. They will vary exactly in proportion as the resources called on to effect the variation are more or less expensive than before. On the two older methods they would not vary, provided the time or wages value remained unchanged.

Again, in the new machine rate we do get a factor of cost which is just as significant as the wages itself. It is a factor which varies as method varies. Cheaper methods of doing work will be promptly reflected in this factor. And the significance of the supplementary rate has already been alluded to.

In comparing two costs on the new method, we have three factors to read, each of which conveys spscial information:—1, direct wages—nothing need be said about this; 2, the machine rate; this will show whether a change of method or process has resulted in an economy if read in connection with wages. If cost has varied, it is easy to see wherein it has varied—the play of the three factors of time, wages, and machine rents being distinguishable—and deductions can be drawn whether there has been a net gain or loss by the change of method. For it will be seen that a decrease in wages may be counterbalanced by a rise in machine rent, or the shorter time taken by a high-priced man may be found to have a corresponding gain in a lower charge for machine rent. In fact as before said, the play of the factors amongst themselves and their mutual relationships can be studied minutely. This is impossible on any of the averaging methods.

Finally, there is the supplementary rate, the third factor of cost. This will be of chief significance as showing what proportion of the total cost was due to the accidental features of the commercial situation at any period. This factor has never been separated before from the general body of the costs. On an averaging system, if we find a reduced cost to-day as against the cost of the same article a year ago, we cannot, if the method has in the meantime been varied, say what is the reason of the reduction. The manufacturing efficiency due to method was intermixed with the commercial efficiency due to state of trade. In the new method, the state of trade or the general efficiency of management affect the supplementary rate alone, and a similar cost at two different periods might, if analysed, show that what had been gained in method had been neutralised by a fall in the volume of trade, or by a muddled condition of shop organisation.

In the next article some of the problems raised by the application of the method to mass production will be discussed, especially with regard to the influence of nearly automatic machines. One or two examples of job costs under varying conditions, and the lesson that may be read from an examination of them, will be presented.

THE DEVELOPMENT OF THE BY-PRODUCT COKING INDUSTRY.

By William Gilbert Irwin.

Possibly the most striking phase of modern manufacturing economy is the progressive utilisation of former waste products. As the competitive struggle for existence becomes keener, more study is put upon extracting values from materials formerly thrown away. Europe has centred attention more closely upon this point. In the United States, materials being lavishly abundant and labour expensive, the study of lessening the cost of production naturally took at first a different trend. There is a tendency now to approximate practice in this line, as in all others, and Mr. Irwin considers a development in which America has most to learn from Britain and the Continent.—The Editors.

THE development of manufacturing industries to their present greatness has been due in a large degree to the advances made in fuel supplies. Just as anthracite coal succeeded charcoal in the United States for furnace and foundry purposes so, too, has coke supplanted the latter fuel product. For many years there were no marked advances in the improvement of fuel coke, but to-day the coke industry is undergoing a decided revolution in the methods of its operation. Changes in coking operations, long foreshadowed by economic conditions of fuel production and involving nothing less than the complete eradication of the old bee-hive oven and the substitution of the various new by-product systems of coke making, are now under way in the coking fields of the United States. In addition to bringing about decided improvements in the manufacture of fuel coke, these new economic systems, at the same time, will make possible the complete utilization of the valuable by-products which are an entire waste by the bee-hive-oven system of coke manufacture.

Were these propositions yet in their experimental stages, such radical innovations might seem chimerical even in these days of science and economy as applied to industrial operations. However, by-product coking has already had considerable exploitation, especially in European countries. In the coking fields of continental Europe the various types of the by-product system have pretty thoroughly supplanted the bee-hive oven. The same is now true of the coking fields of England, the coke makers of that country finally following the lead of Germany, France, and Belgium. While by-product coking has made some progress in the United States during the past eight or nine years, American coke makers have been slow to adopt these economic systems. But it must be remembered that a radical change from the bee-hive oven system, now in general use in the United States, involves a gigantic financial problem. Estimating the cost of a complete bee-hive oven at $400, we would have invested in the 50,000 ovens of this type now in operation in the country not less than $20,000,000. To supplant these ovens with a sufficient number of by-product ovens to insure a maintenance of the present annual coke output would cost something like $40,000,000. With such enormous sums at stake, it would scarcely be a good stroke of business to abandon at once the old coking methods for the new types, even though the utilization of the by-products would insure a handsome annual profit over the old bee-hive system.

While the advantages of the new system are apparent and manifold, all the foregoing would indicate that their introduction must be the result of a slow change from the old to the new ideas. In these days of prosperity the loss of time resulting from a radical change in methods of coke making would mean a loss of millions of dollars to the operators. Today the result of one day's operation in this form of fuel making easily yields the same returns financially as did three days' operation a few years ago, when the coke industry was at ebb tide and coke was selling for one dollar per ton. Today the vital question with iron and steel manufacturers is to obtain their coke supply; the method of its manufacture and its quality, in most cases, are secondary considerations. Illustrative of this fact I may here state that the coke makers of the Connellsville region have been resorting to numerous experiments looking to increases in their output, but it is plainly evident that the only logical solution of the question of time-economy in coke making lies in the adoption of the new by-product coking systems. All attempts to reduce the time of coking by improvements in the bee-hive oven have resulted unsatisfactorily. When coke was first manufactured in the Connellsville region no ovens were used, the coal being banked in huge piles in open ricks on the ground, with air channels running through to give air draughts, much after the manner in which farmers burn lime. In this primitive method, which is today being resorted to in order to increase the coke output, it requires a much longer time to complete the coking process than when ovens are used;

but so far as concerns the chemical enrichment of the product, this primitive system is almost on a par with the bee-hive oven. These open coke ricks in no way interfere with the operation of the oven plant, and the coke thus produced is a clear gain in production. With a natural coking coal, such as that of the Connellsville region, this open-air coke making has no apparent deleterious effect upon the product. In semi-coking and other coals it would be altogether impracticable, as would the successful operation of bee-hive ovens.

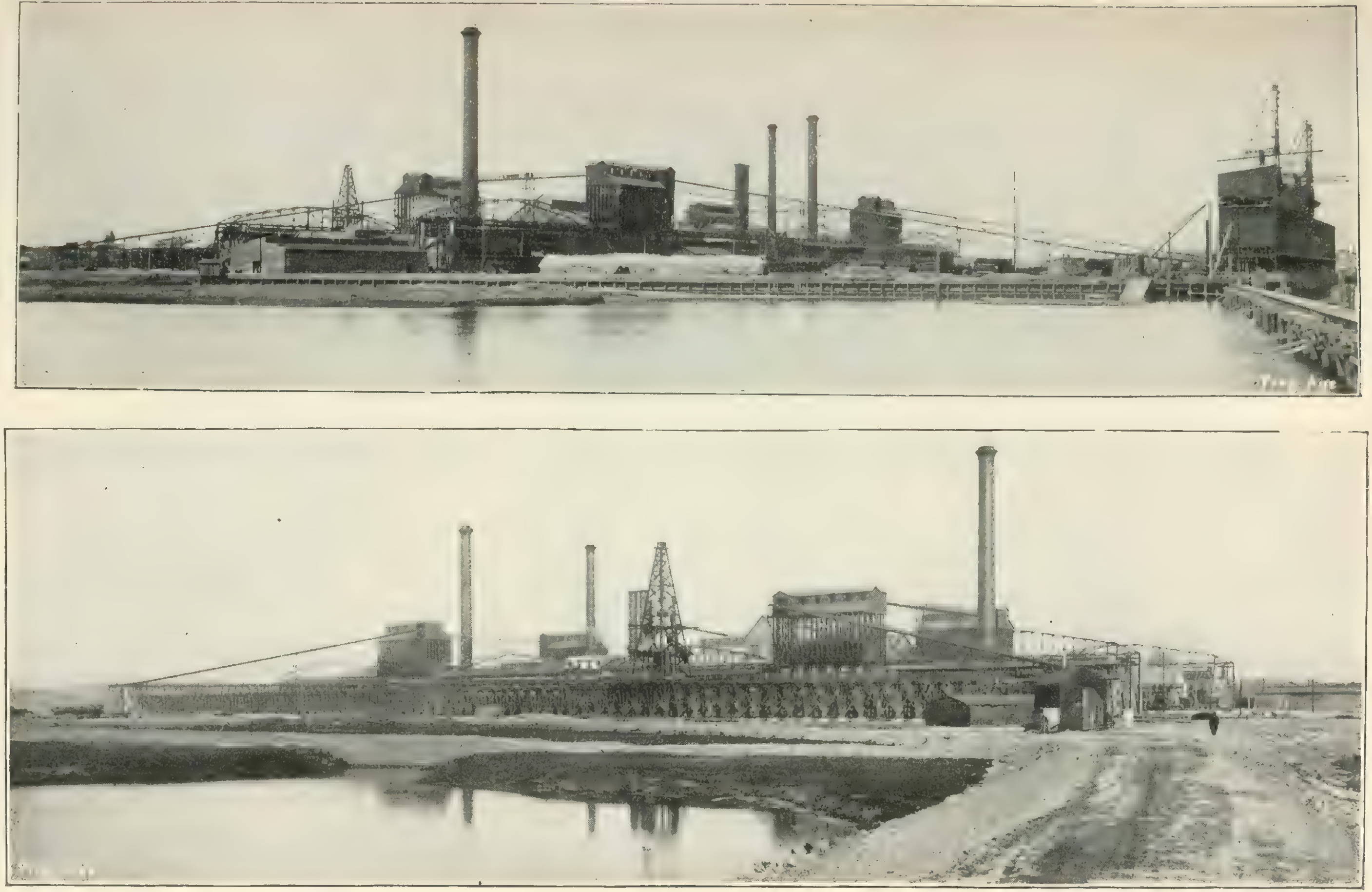
But even in the face of these prosperous days for the coke industry, the by-product question is by no means a dead one with American coke makers. Like the fuel producers elsewhere, they are rapidly coming to understand better just what the new coking systems mean in dollars and cents, and to see how they will be enabled by these new systems to turn to profit those products of coke making which are entirely lost by the bee-hive-oven system.

The story of the inception and growth of the ideas of by-product coking is by no means written history, for although we have frequent mention of the progress and development of these ideas in former years, yet there is little known of the vicissitudes which must have been encountered by the early advocates of the new type of coking ovens. We infer from the slow introduction of these plants and from the fact that all pioneer exploiters of new ideas in science and industry have been thus obstructed, that much difficulty was experienced by the early advocates of the by-product coking methods.

These new coking plans were originated in Germany, France, and Belgium, and these countries still hold the foremost rank in the use of the systems. While America leads the world in mechanical and inventive genius, the new coking system forms one of the few exceptions. The right of the countries of continental Europe to pre-eminence in the field of chemical research has not, however, until recently, been disputed by the United States, and as the by-product coking industry readily resolves itself into a complex chemical one, its evolution has lain more directly within the field of the careful and learned men of Europe than within the field of the busy American. Another incentive to the development and introduction of these new ideas in the coking fields of continental Europe lies in the fact that their coal supplies are comparatively limited; hence the necessity of rigid economy.

The first mention of the by-product oven dates back to 1768, in which year tar was produced by a chemical process in a by-product oven at Fischback, in the Saarbrucken coal fields in the Rhineland provinces of Germany. Systematic experiments along these lines were made in France and Belgium many years ago, and in 1863 a by-product-oven plant was in efficient operation at St. Etienne, France. From that time until 1882, when Mr. L. Semet, an eminent engineer and a director of the firm of Solvay & Company, of Brussels, Belgium, perfected the Semet-Solvay retort coke-oven system, this departure in fuel making underwent a gradual development. The first plant of this pattern was installed at Mons, Belgium, in 1882, and since that time the system has met with great success in many coking fields. A little later the Otto-Hoffman system was perfected in Germany, and under the exploitation of leading German fire-brick manufacturers this system has had a wide development at home and has been successfully introduced into the coking fields of other countries. In the meanwhile the Simon-Carve by-product system was being perfected in France, and during the past ten or twelve years a number of other systems modeled somewhat after these pioneer retort systems have been evolved.

These new systems of coke making were slow to obtain favor with the English coke makers. There the same conditions which now confront these new systems in the United States were met. In 1882 Sir Lowthian Bell, an eminent authority on such matters, conducted exhaustive tests based on the operation of the Simon-Carve by-product system, and in his published reports he advised against the introduction of the new systems, stating that the coke thus produced was at least 10 per cent. inferior to the bee-hive-oven product for furnace, foundry, and other industrial purposes, and his reports were otherwise adverse to the introduction of the new systems. However, the best authorities are liable to error, and later experiments proved that Sir Lowthian was wrong in his deductions. It remained for Sir Burnett Samuelson to dispute the conclusions of the above mentioned authority, and by conclusive experiments and actual tests to show that the product of the new systems was superior to the bee-hive-oven coke, the coal being coked in ovens of the opposing systems having the same uniform composition. But even these conclusions, coupled with the acknowledgement of error on the part of Sir Lowthian, did not for a time completely remove the skepticism on the part of the English coke makers. It required almost a dozen years for the by-product methods as represented by the Semet-Solvay and the Otto-Hoffman systems, to obtain a firm foothold in England. These and other systems have been in very successful operation in that country for the past eight or ten years, and the by-product-oven output now forms an important part of the coke production there, while the utilization of the by-products and the conversion of these to the uses of modern industry now form a



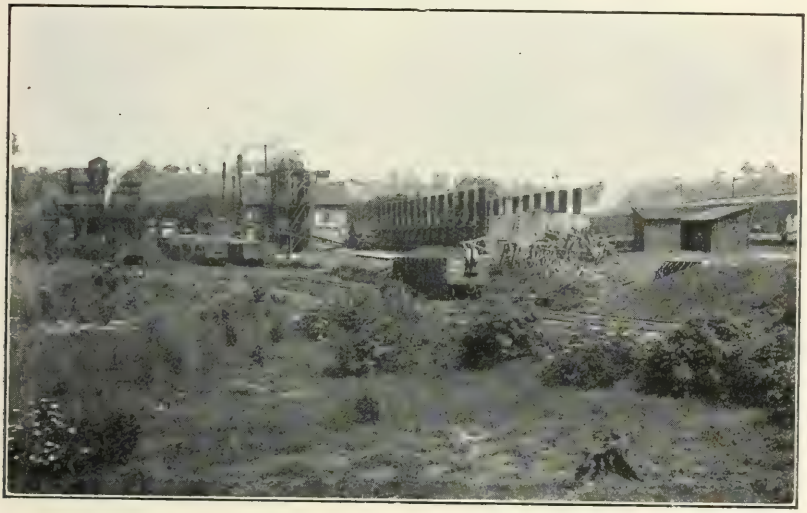
EVERETT WORKS OF THE NEW ENGLAND GAS & COKE CO., BOSTON, MASS., WHERE THE CANADIAN COAL OF THE DOMINION COAL CO. IS COKED IN OTTO-HOFFMAN BY-PRODUCT OVENS.

valuable subsidiary industry in that country. By-product coking plants are now in operation in all the coking fields of continental Europe, in Australia, and in Japan, and today the greatest activities in these new ideas are being experienced in the United States and in Canada.

The Semet-Solvay and the Otto-Hoffman systems represent opposing by-product types, in so far as operation and by-product recovery is concerned; and both of these systems are represented by a number of plants in operation in the United States today. The chief points of difference in these two types lie in the fact that the Otto-Hoffman uses vertical flues and employs the regenerative system of firing, while the Semet-Solvay process uses horizontal flues and employs the continuous recuperative firing system. The points of merit possessed by these two types will be discussed farther on in this article. The Coppee by-product system is a later system evolved by E. Coppee of Brussels. It employs vertical flues without regenerative firing. The Simon-Carve system employs horizontal flues and thick walls, and differs from the Semet-Solvay system in that the latter type employs thin, or hollow, walls. C. Bernard, a Frenchman, has perfected a system similar to the Coppee oven and this system is now in use in France. The Bauer by-product oven is now used at the Hanover collieries of the Krupps. This type of the by-product oven is built in small units and with either vertical or horizontal flues. A plant of this type with vertical flues is now in operation at Creusot, France. The Newton-Chamber by-product oven is the production of English skill, and is modeled somewhat after the Otto-Hoffman system, using vertical flues and involving continuous firing. Two plants of this type have been installed in the United States.

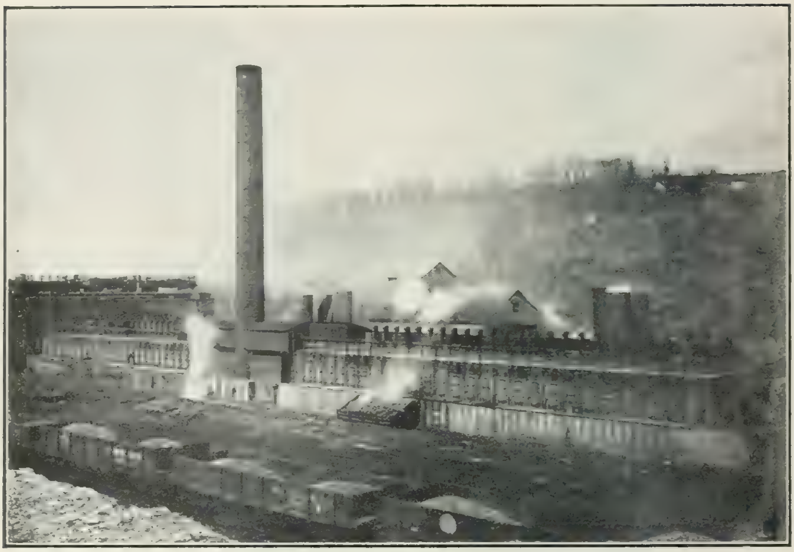
All of the above are European systems. In America a number of by-product coking systems have lately been evolved. A plant of the Keneval system, consisting of three ovens, has been installed at Knoxville, Tennessee. This battery is of three ovens, 25 feet in length, 24 feet 6 inches in width, and 21 feet high, with ascension pipes and hydraulic pipes on the top. The charge of each of the ovens is 10 tons of slack, the return in coke being from 75 per cent. from washed slack down to 68 per cent. from unwashed coal. Coal from mines in all parts of the country has been coked at this experimental plant. This by-product system differs materially from all of the European systems.

The Hemingway retort-oven process is another of the new systems now being perfected, and John Fulton, the well known coal and coke expert long connected with the Cambria Steel Company at Johnstown, Pa., has perfected a by-product coke oven. The Slocum retort oven is the work of Dr. F. S. Slocum, of the Pittsburg Gas Company, and several of these ovens have been installed at Bolivar, Pa. The Jones & Laughlins Company, of Pittsburg, has lately installed a complete retort-oven plant on South Side, Pittsburg, at which plant the slack coal from their mines is coked at the point of consumption; but as yet this company has made no uniform attempt to utilize the by-products.



PLANT OF 30 NEWTON-CHAMBER BY-PRODUCT COKE OVENS, LATROBE COKE AND COAL CO., LATROBE, PA.

All retort ovens are closed and air-tight, at least during the coking process. In shape and operation they differ widely from the old bee-hive oven. This oven, of which over 50,000 are in operation in the United States at this day, is a square oven, built usually in blocks, and the standard oven of this type has an outside diameter of about 12 feet and a height of 8 feet. Its interior much resembles an old-fashioned bee-hive, from which it derives its name. There is a circular opening in the top, through which the oven is charged and through which the gases are permitted to escape into the air during the coking process. The door in the lower front side is closed during the time of coking, and it is through this opening that the coke is "drawn." In this system no attention whatever is given to the recovery of by-products. In the various recovery systems the coking chamber is very narrow, varying in width from 15 to 30 or 40 inches, save in the Newton-Chamber and several of the other systems which have a wider coking chamber.

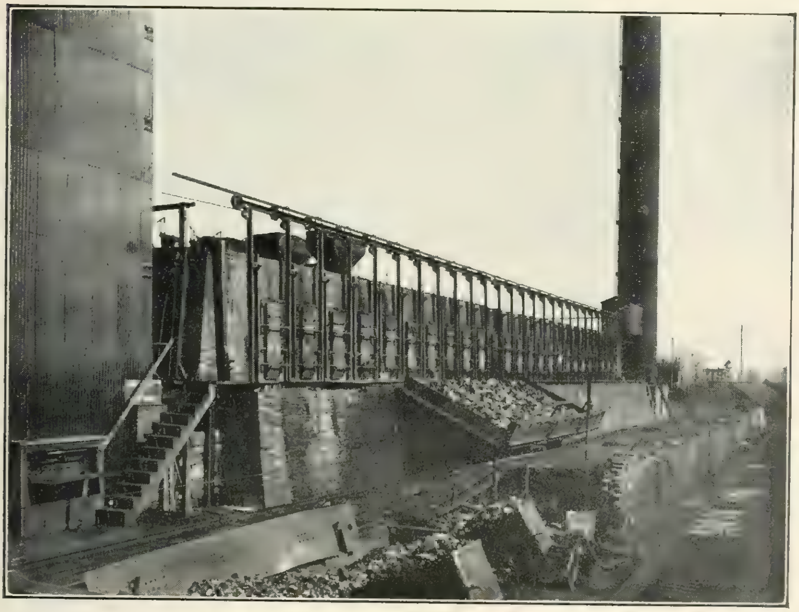


SEMET-SOLVAY COKING OVENS AT DUNBAR, PA.

The height of most of the by-product ovens varies from 7 to 8 feet. The exclusion of air from the coking chamber does away with combustion there, and the heat necessary for coking comes from the combustion of air and gas in the flues, and in the sides and bottoms of the ovens.

No provision for the chemical enrichment of the product is made in the bee-hive oven, nor is there any provision for definite results. When the charge is leveled in these ovens there remains a foot or more empty space in the top part of the oven. In this system the mass of coal, as it fuses into coke, swells and rises, and if on quenching it falls back to nearly its original bulk, a hard coke is produced; otherwise a soft coke results. The bee-hive oven is adapted for coking a natural coking coal only, while the retort oven, it has been demonstrated, will to a large extent adapt itself to semi-coking coals, and in many cases a good quality of coke has been produced by these new systems where the bee-hive oven has proven a complete failure. Nor does the retort oven admit of variation in the product. When the mass of coal is being fused into coke in the narrow retort oven it cannot expand, and is compressed vertically as well as laterally; the result is a uniform product, its hardness varying according to the charge of coal in the oven. For foundry and furnace purposes bee-hive-oven coke is superior to anthracite coal, but in some respects inferior to by-product-oven coke, especially when the two cokes are produced under similar conditions. Anthracite coal was at one time a bituminous coal, and in its present state it is really a coke produced by nature, the excess volatile matter and other original chemical constituents having been expelled by the forces of nature during the earth's chaotic period. This coal is much freer from volatile matter than ordinary coke and it contains more carbon, but these advantages in its favor are overbalanced by its density, which is caused by the great pressure to which it was subjected while in its semi-plastic condition. In the bee-hive-oven coke the porosity is great, but toughness and hardness, two essentials of a perfect furnace and foundry fuel, are not always rightly combined. Through the equal distribution of the cell space and the greater amount of carbon present in the by-product-oven coke all the essentials of a perfect fuel for industrial operations are eminently combined. Later on some statements and statistics relative to the comparative value of the bee-hive and by-product-oven coke will be given.

The by-product-coking industry, so far as concerns the American coking fields, dates from about January 1st, 1892, when The Solvay Process Company, manufacturers of soda, put into operation an experimental plant of twelve ovens with by-product-recovery apparatus, at Syracuse, N. Y., for the purpose of obtaining a coke supply for their works, and also to produce ammonia for their soda manufacture.



SEMET-SOLVAY OVENS AT SHARON, PA.

For several years these ovens were successfully operated, during which time nearly all kinds of American and Canadian coking and semi-coking coals were thoroughly tested, and the coke thus manufactured was subjected to the most rigorous furnace and foundry uses with gratifying results. The increased production of these by-product ovens over the bee-hive oven ranged all the way from 15 per cent. to 40 per cent.

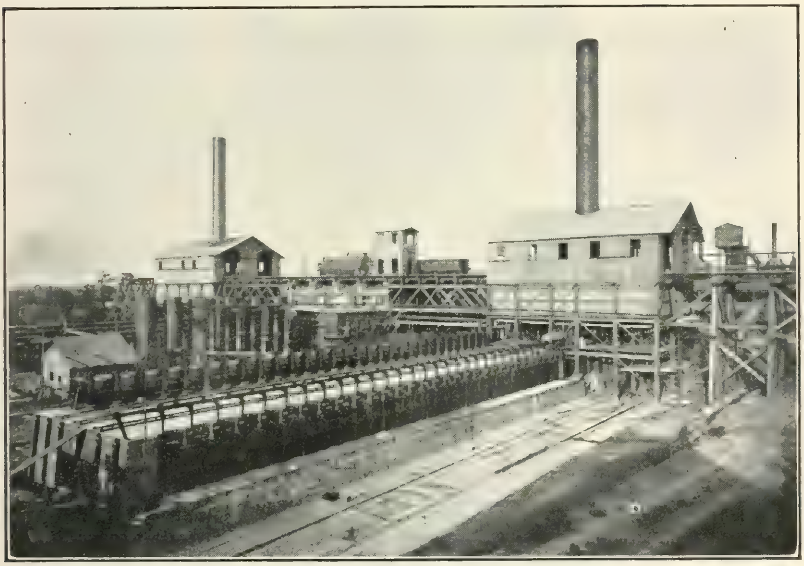
Shortly after the successful installation of this plant, the Semet-Solvay Company was organized to develop the use of these ovens in the United States. The first American coke-making concern to adopt this by-product system was the Dunbar Furnace Co., which installed a plant of fifty of these ovens at Dunbar, Pa., in the heart of the Connellsville coke region, in 1895; and the operation of this pioneer by-product plant has been so successful that the erection of an additional lot of ovens is contemplated, which will bring the plant up to over two and one-half times its present size. A few months later a plant of twenty-five of these ovens was put into run by the Sharon Steel Company, at Sharon, Pa., and in 1897 a plant of sixty ovens was built by the Riverside Iron Works at Wheeling, W. Va., and since that time the plant has been increased to one hundred and twenty ovens, the increase being of the new type of oven having 6-tons capacity per twenty-four hours.

At Ensley, Ala., in 1897, a plant of one hundred and twenty ovens was built to supply the blast furnaces of the Tennessee Coal, Iron, & Railroad Co. with coke, and during the past year this plant has been more than doubled in size. The gas is being used very successfully in the steel plant of the Alabama Steel & Ship-Building Co., and has very thoroughly proved its value in metallurgical work.

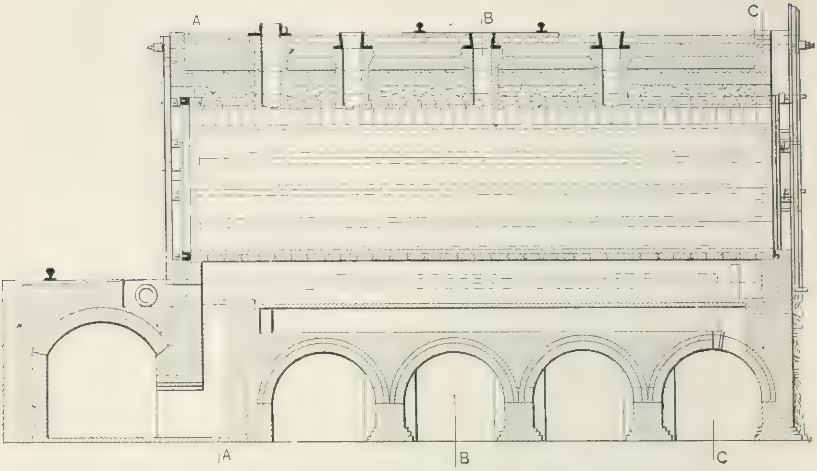
During 1898 a plant of ten ovens operated by the Peoples' Heat & Light Co., at Halifax, N. S., was changed to the Semet-Solvay type, the coke being sold largely for domestic consumption and the gas being used as the sole gas supply for lighting the city of Halifax. This plant was the first to use coke-oven gas successfully for illuminating purposes without enrichment.

A plant of 200-tons daily capacity is just being put into run at Detroit, Mich., in connection with the branch of The Solvay Process Company's works there, and a number of other plants varying in size from two hundred and forty to one hundred and twenty ovens each are in the preliminary stages of construction or under active negotiation.

The Semet-Solvay ovens are built in batteries, preferably of thirty ovens each, or multiples thereof. A single oven is 30 feet long, 7 feet 6 inches in height, and from 16 inches to 20 inches wide. The distinguishing characteristic of oven construction is illustrated in the accompanying longitudinal and cross sections. It will be seen that the ovens belong to the horizontal-flue type—that is, the oven chamber is heated by means of four horizontal flues on each side. These flues are heated by the combustion of gas which is admitted at the ends of all but the lowest flue, where it mixes with air heated by means of the regenerative arrangement shown at the bottom of the oven, which produces amply high temperature for the operations of the coking process. The horizontal-flue system has the important advantages of permitting the inspection of any flue at all times, and the accurate distribution of the heat in the flues so as to prevent the possibility of uneven heating of the coking charge. It will be noticed by examination of the cross-sectional view that the tiles composing the flues are entirely independent of the main structure of the oven. This permits the expansion and contraction of these flues, due to the change of temperature from the time when the cold wet charge of coal is dropped into the oven up to the completion of the coking process, without in any way affecting the main brickwork of the oven construction. This insures a very much longer life to the ovens than where the flue walls

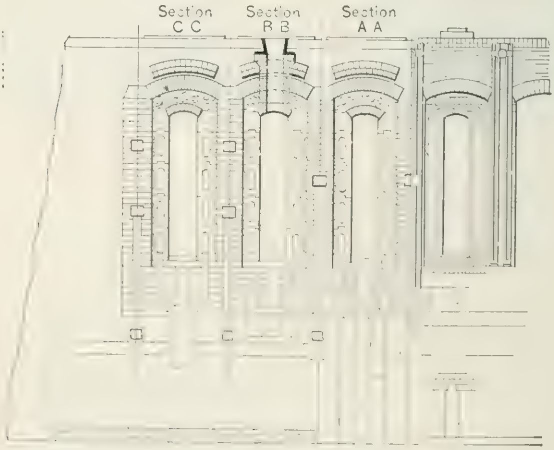


ENSLEY, ALA., BY-PRODUCT-COKING PLANT. SEMET-SOLVAY OVENS.



LONGITUDINAL SECTION OF SEMET-SOLVAY RETORT COKE OVEN.

form an integral part of the system and the whole mass of brick work is distorted and racked by the repeated expansion and contraction of the flue walls, which is an essential part of the process of charging, heating up to the final coking temperature, and discharging of the coked charge, which takes place every day in each oven. The waste gases pass from the oven flues into a general collecting flue, thence to the boilers, where they furnish steam for the operation of the by-product apparatus, and pass to the chimney at so low a temperature as to be of no further value. The ovens are charged through three openings in the top, the charge being from 12,000 to 12,500 pounds to the oven. The charge is leveled by means of hoes operated from each end of the oven and the oven doors tightly sealed with fire-clay luting; and the gas, which begins to come off immediately, is turned into the mains for treatment in the by-product apparatus.



TRANSVERSE SECTION OF SEMET-SOLVAY OVEN, REFERRED TO LONGITUDINAL SECTION ABOVE.

The time of the coking depends upon the quality of the coal and width of the oven. With Connellsville coal, containing 32 per cent. volatile matter, coke is produced in Semet-Solvay ovens of the usual width, 16½ inches, in from 20 to 24 hours, while but 18 to 20 hours are required to coke Pocahontas coal containing 19 per cent. of volatile matter; an increase in the width of the oven increasing the coking time about proportionately. There may be a difference in the time of coking two coals containing the same percentage of volatile matter, owing to the differences in the chemical composition of the volatile matter.

At the close of the coking process, the doors are opened and the coke discharged onto a car specially arranged for receiving the coke and quenching it with the greatest thoroughness. The doors are closed as soon as the ram is withdrawn and a fresh charge introduced, the whole operation of pushing and recharging occupying but a short time.

The control of the temperature of the flues is of special importance for the production of good coke, and the method of admitting the gas into several places and at the ends of the horizontal flues, which is adhered to in the Semet-Solvay system, has been found to be of special value. The top flues of the oven are maintained at from 800 to 1,000 degrees centigrade, the middle flues from 1,150 to 1,250 degrees, and the bottom flues at about 1,100 degrees.

I herewith append a comparison of the yield of the Semet-Solvay and the Bee-Hive systems:

Kind of coal coked.	Yield, Bee-Hive.	Yield, Semet-Solvay.
Connellsville	66 per cent.	72 per cent.
Pocahontas	62 per cent.	80 per cent.
Morris Run	60 per cent.	78 per cent.
Alabama coals	60 per cent.	72 per cent.

The Cambria Steel Company was the pioneer industrial concern and coke producer in the United States in the adoption and installation of by-product coking plant. As has been already mentioned, a plant of Semet-Solvay ovens was installed at the Dunbar furnace plant of this company at Dunbar, Pa., in 1895. At the same time the United Coke & Gas Company of New York, which concern controls the American rights of the Otto-Hoffman by-product oven, contracted with the Cambria Steel Company for the erection of a plant of sixty Otto-Hoffman ovens at Johnstown, Pa., and this plant was put into operation early the following year. An addition of one hundred Otto-Hoffman ovens has since been made to this plant and another is proposed.

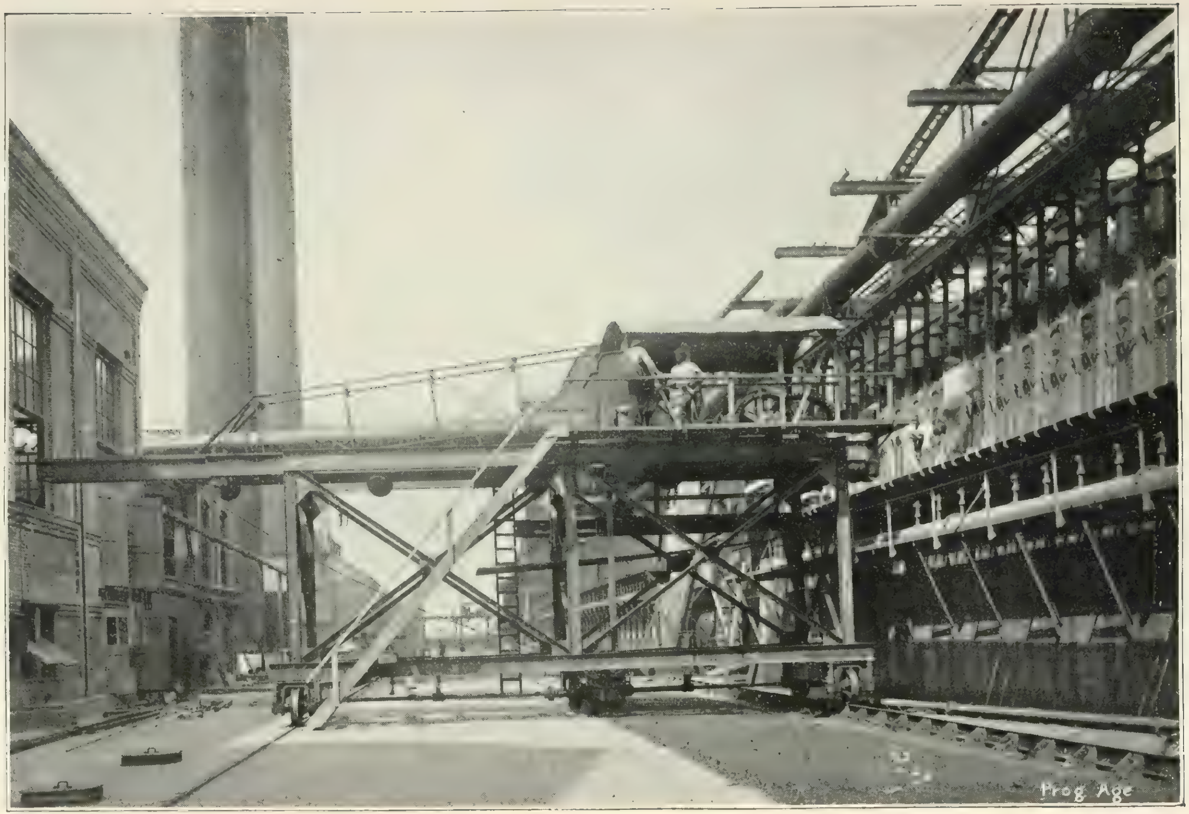
The Pittsburg Gas & Coke Company has installed a plant of one hundred and twenty ovens at Glassport (also called Otto) Pa., near

Pittsburg. For a time slack coal from the gas-coal mines of the Pittsburg district was used at this plant, and the coke produced was used in the furnaces of Pittsburg and elsewhere with excellent result. Owing to the inability of the company to obtain a sufficient supply of this slack coal, run-of-mine coal from the mines of the Washington Coal & Coke Company, located in the Youghiogheny coal fields, is now used at the Glassport by-product plant and the best quality of furnace and foundry coke is there produced.

The New England Gas & Coke Company has now in operation a plant of four hundred Otto-Hoffman ovens, and a large addition is now being planned, the original plant having been laid out for one thousand two hundred ovens. The Dominion Iron & Steel Company has now in operation a plant of four hundred ovens of this pattern, and at Hamilton, Ohio, the Hamilton Otto Coke Company is operating a plant of fifty of these ovens for the manufacture of foundry coke and illuminating gas. In addition to the above there are now under construction two hundred and thirty-two Otto-Hoffman ovens for the Lackawanna Iron & Steel Company at Lebanon, Pa., five hundred and sixty-four similar ovens for the same company at Buffalo, N. Y., and one hundred ovens of the same type for the South Jersey Gas, Electric & Traction Company at Camden, N. J., which brings the number of Otto-Hoffman ovens either in operation or under construction in the States up to two thousand and twenty-six. The two plants now being installed for the Lackawanna Iron & Steel Company will engage chiefly in the manufacture of furnace coke, the by-product recovery being a secondary consideration, while the plant at Camden will supply the cities of Camden and Trenton with illuminating gas and manufacture coke as a subsidiary industry.

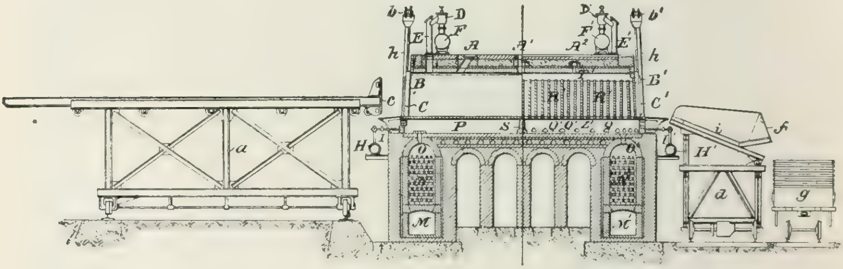
The Otto-Hoffman ovens are built in batteries, each battery forming one working unit. While this type of oven varies in dimension to suit required conditions, the standard is 33 feet in length, 6 feet in height, and in width varies from 16 to 22 inches. They take a charge of 6 to 7 tons to the oven, and the finished coke is discharged by means of automatic pushers. Electrical charging machines are employed and the coal is leveled in the ovens by means of scrapers. The heating system of this type is based upon the Siemens regenerative principle. The ovens are built with thirty-two vertical flues, sixteen in each of the side walls.

The coke-oven gas, freed from tar and ammonia, is partly sent back to the ovens, and from the fuel-gas mains tuyeres carry this gas on either side of the oven into the combustion chambers, the gas being



COKE PUSHER AT A BATTERY OF OTTO-HOFFMAN OVENS, NEW ENGLAND GAS & COKE COMPANY.

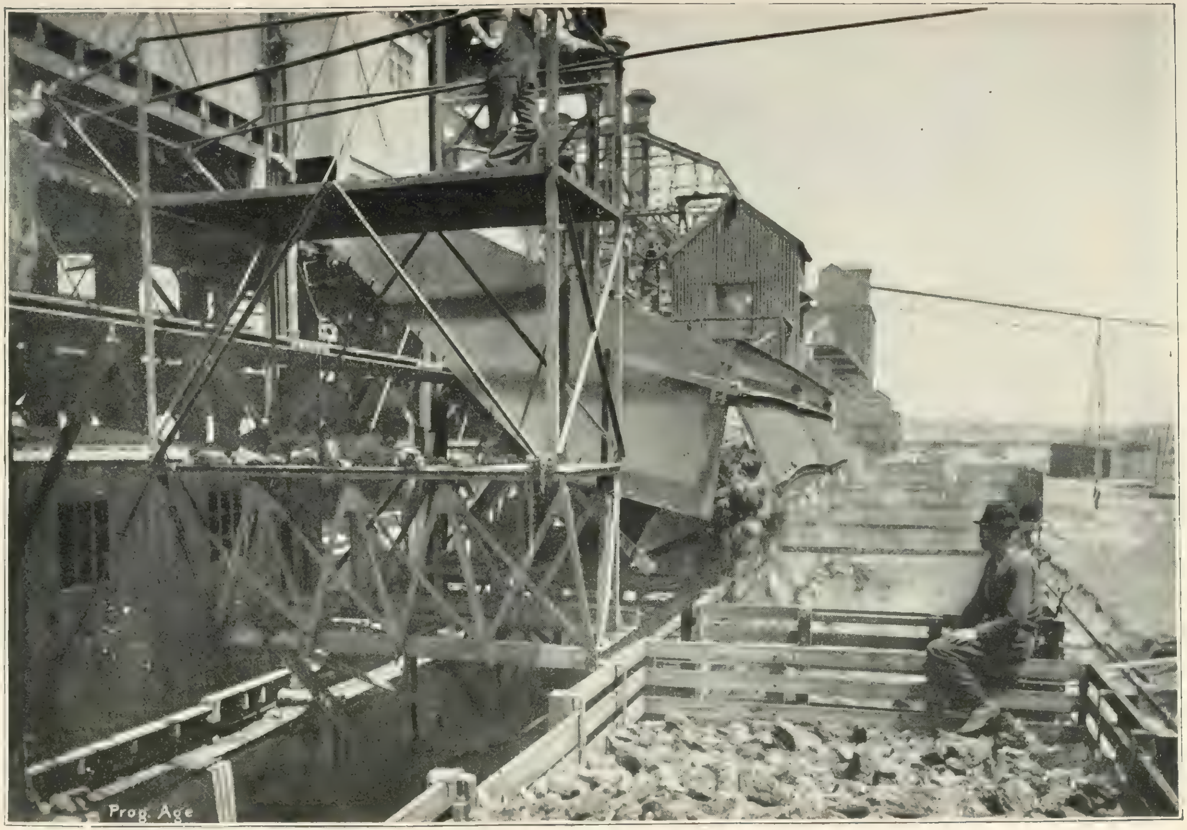
introduced alternately at each side, during which time cold air is blown into the bottom chamber of the regenerator in order to pass upward through the checker work which has been previously heated to a high temperature. The hot air is then introduced through the porthole into the bottom flue of each oven, and from there it passes through small openings into the adjoining chamber where the combustion of the gas takes place. The air supplied to the gas flame has a temperature of 1,000 degrees centigrade. The products of combustion are expanded in the bottom chambers until their course is checked by partition walls, when they rise through the vertical flues on one side and descend through the corresponding flues on the other side. Then they pass into a gas chamber and thence into the bottom flue and through the porthole into the regenerator. The heat remaining in the gas is stored up in the checker work of the regenerator, and from there the gases pass through a flue to the boilers and thence escape into the stack. While one generator is thus being heated the other has been cooled by the pre-heating of air and, by a valve, the gas is reversed every hour or so. At the different plants of the Otto-Hoffman system numerous tests as to the economy of the regenerative system of firing have been made, and for the system its numerous advocates are in a position to demonstrate a decided economy.



SECTION THROUGH OTTO-HOFFMAN OVEN WITH PUSHER, COKE LOADER, AND CAR.

Coke produced by the Otto-Hoffman by-product system possesses many merits over bee-hive-oven coke, and the same is true of coke produced by any of the by-product coking systems. The average analysis of the coke produced at the Glassport plant of the Otto-Hoffman system gives: volatile matter, 1 per cent.; fixed carbon, 86.47 per cent.; ash, 11.57 per cent.; moisture, 3.17 per cent.; sulphur, 0.96 per cent.; phosphorus, 0.0107 per cent.

Something regarding the recovery of by-products by the Semet-Solvay system has already been given. The construction of the by-



COKE LOADER DISCHARGING A BATTERY OF OTTO-HOFFMAN OVENS, NEW ENGLAND GAS & COKE CO.

product apparatus in the various systems may differ materially, but the processes by which by-products are recovered and converted to the uses of modern industry differ but little, as do the results obtained. Without regard to any particular type of retort oven, it is now quite generally accepted by fuel users that the retort-oven coke is superior to the bee-hive-oven product, the coal coked being of the same character. The gain in production by the new systems runs from 10 to 40 per cent. The cost of a Semet-Solvay or an Otto-Hoffman oven equipped with by-product-recovery apparatus can be placed at from $2,500 to $3,000. Either type is considerably larger than a bee-hive oven; the percentage of coke yield is much greater; and the by-product utilized brings the efficiency of either pattern of the by-product oven up to four or five times that of the bee-hive oven, while the durability of the new type of oven is such as to add greatly to their advantage. By-product-recovery apparatus is also adaptable to the regular bee-hive oven. At Pocahontas, Va., a plant of fifty-six bee-hive ovens have been converted into a modified type of Newton-Chamber retort ovens. The Newton-Chamber oven much resembles the bee-hive oven. At Latrobe, Pa., the Latrobe Coke & Coal Company installed a plant of thirty ovens, but they have been out of operation for some time.

The primary products recovered from the coking of coal are coke, fuel gas, ammonia, and tar. In the bee-hive oven all of these save coke are a complete loss. In the by-product coking system a portion of the gas is consumed for heating the ovens in the coking process. The surplus fuel gas can either be converted into illuminating gas, or used for power in gas engines or for other purposes where fuel gas is required. The amount of gas evolved from any coal is proportionate to the volatile matter contained in the coal and the heat to which the coal is exposed during the coking process, or in the extraction of the component gas. In a coal like the Connellsville coking coal, containing from 29 per cent. to 35 per cent. of volatile matter, there are from 8,000 to a little over 9,000 cubic feet of gas per short ton. On this basis the 30,000,000 tons of coal coked in the United States last year would produce more than 250,000,000,000 cubic feet of gas. Allowing one-half of this production for consumption in the oven, we have remaining over 120,000,000,000, or about one-half the annual natural gas production during the height of that excitement. To convert this fuel gas into illuminating gas involves a change in the operation of the oven so that gas produced with the recuperation of air and gas may be burned in the flues instead of the rich coke-oven gas.

Ammonia, that is ammonia sulphate, is the most valuable of the by-products of coke making, it having a market value of about $20 per ton. The yield of this by-product from each ton of coal coked is about 20 pounds, or a total yield of over 300,000 tons for the 30,000,000 tons of coal coked in the States last year, which would make the value of this by-product over $6,000,000. The yield of tar is about 60 pounds per ton of coal coked. By-product tar is superior to tar that comes from the gas works. It contains a less amount of pitch, and its fuel value is about $5 per ton, which would give a value of nearly $5,000,000 for this product from the coal consumed in coking last year. In their primary state the combined by-products of coke making have a value of close to one dollar for each ton of coal coked.

However, we can add to the $30,000,000, which represents the value of the by-products which would be saved by the new coking systems, the gain of 15 to 20 per cent. in coke production which they make possible; we can also estimate the saving in operation, the gain from durability of construction, and the economy in the way of improved equipment, and thus obtain the sum total in favor of the new coking systems. Since the introduction of these new systems into America less than ten years ago over four thousand of these ovens of various types have been put into operation, and their success has been such as to insure their rapid growth and the future predominance of these ideas. Time will come when economy will be a necessary factor in coal matters in the western continent, just as it is in England and in continental Europe at this day.

The by-product systems of coke making are destined to shift the coking industry to the manufacturing centers and to the points of coke consumption, where they will undoubtedly find their greatest development. Already a number of these plants are in operation at the iron and steel manufacturing centers in the United States, and furnace and foundry owners are now giving the by-product-coking question much consideration. With such plants in operation in the manufacturing centers the "excess gas" can be readily utilized for industrial operations, either for furnace or foundry operations or for the generation of steam or gas-engine power, this innovation enabling the operation of such plants on the most economic basis. Coal is much heavier than coke, but can be shipped in almost any kind of cars; and this departure in coke making possesses many advantageous features. The by-product coking systems are also receiving favorable attention in connection with the abatement of the smoke nuisance in cities, and other new opportunities are being opened up by these new ideas.

OPPORTUNITIES FOR BETTERING THE WORK OF THE FOUNDRY.

By Percy Longmuir.

Comment has been made previously in this Magazine upon the relative backwardness of the foundry in the matter of adaptation to economical production. It is the more strange that this should be allowed to continue, because imperfect castings mean more work and more expensive work in the shop, where low cost of production is now a matter of the closest study. Mr. Longmuir sketches broadly conditions as they too often are, and as they might be to the advantage not only of the foundry itself, but of the workshop to which it furnishes materials of construction.—The Editors.

ULTIMATELY, the aim of any foundry is to turn out good castings in an economical manner, and the success of the foundry is or should be based on the final cost of the finished castings. Any reduction of this cost, either in the foundry or by turning out castings in such a manner that less after treatment is required to bring them down to working conditions, is to be welcomed. The condition of the metal in a casting, the method adopted in its production, and its requirement of the maximum or minimum of machining, are strong factors in determining economy; and in these three items alone a wealth of opportunity to increase the efficiency of a foundry may be found.

Circumstances have compelled the recognition of these facts in British speciality foundries, this recognition crystallising out into more or less definite systems of working and organisation and an acknowledgement of mechanical aids and labour-saving devices. But though recognised in the speciality establishment, these matters in the general foundry do not receive the attention warranted by their importance. A vast field of undeveloped opportunity for the general founder lies immediately to hand. Imagine for one moment the extent of this far-reaching field of opportunity, which includes the many foundry operations, materials, tools, etc., various aspects of metallurgy, and types of melting furnaces. Compare this with a similarly extensive field in any other industry, and contrast the number of patents or recent inventions with those in force in the foundry world. Of the few inventions acknowledged in the latter sphere, many are the offspring of non-founders. There are several reasons for this, chief of them being the fact that in many cases special tackle and methods have to be designed for the production of only one casting. Hence founders get into the way of quietly accomplishing any difficult work on hand, and the particular method adopted becomes buried in the archives of their own foundry. It must also be confessed that founders as a rule do not get much encouragement for the development of original methods.

Frequently on the same establishment may be found a machine shop or kindred department fitted with every modern appliance that scientific engineering can devise, and a short distance away a foundry in which everything is noteworthy for its hoary antiquity. Further, these contrasts are not by any means exceptional; they may be seen in many engineering centres. The introduction of mechanical aids or of new methods into the foundry is carried out in far too hap-hazard and unsystematic a manner. A common example is that of a moulding machine; purchased by a member of the firm whose information on foundry matters is supplied by the seller of the machine, it arrives in the foundry almost unannounced and it may stand for some time until a place can be cleared for it, and then be stowed away in some odd corner and given a half-hearted trial.

If these conditions really exist—and few will dispute them—the matter of pointing out foundry opportunities will hardly be a difficult one; the difficulty will rather be in keeping to general ones, for each individual foundry must possess its own separate opportunities.

In the following remarks on iron, steel, and brass foundries, an effort has been made to view each case from a different point of vantage; but though differently treated, conditions in each foundry tend to merge into one another and successful methods in one case may be adapted to meet similar conditions elsewhere. It is in this light that the remarks on iron-foundry conduct must be viewed, for successful methods in iron moulding, after adaptation to local requirements, will meet with the same measure of success in the brass foundry.

With copper fluctuating between £68 and £74 and tin from £120 to £140, it is hardly necessary to say that in the brass foundry the matter of metal and melting are the first considerations. Add to these the cost of fuel, crucibles, wear-and-tear of furnaces; and the price of molten metal per pound may be anything between 5d. and 10d. according to the quality of the alloy. Any opportunity of reducing cost in this direction is therefore worth examination. The first item under this head is naturally that of prevention of loss of metal, which loss may occur in many ways but we will take three as typical:—

(a) Loss by volatilisation.
(b) Loss as shot metal, spillings, fires, etc.
(c) Loss in the ashes.

(a) The loss by volatilisation can hardly be totally prevented, but by intelligent melting and handling this loss may be greatly decreased and by efficient supervision kept normal.

(b) When casting, much needless loss of metal occurs by careless skimming—that is, raking of metal with slag, careless pouring, as spilling metal outside the "gate," filling too full, causing overflow on to foundry floor, and strained castings. It is quite possible that this metal will all be gathered up again, but hardly probable. There is the loss of melting, the labour of collecting and freeing from iron, etc., and the uncertainty as to spillings getting back to their respective qualities again. Indeed, to prevent confusion many foundries adopt the system of classing all the spillings with the commonest metal. That this does not trend toward economy will be shown subsequently in the case of borings.

(c) Brass-foundry ashes are of course always sold, and before leaving the works they may be cursorily looked over and any large pieces of metal picked out; in this condition they will realise from 15 shillings to 18 shillings per ton. Carefully picked and washed, the refuse will still sell for anything between 7 and 10 shillings per ton and the scrap metal obtained from this picking and washing fully justifies the adoption of such a plan.

The treatment of brass turnings and borings offers golden opportunities for systematic and economic handling. The general plan is to deposit all the turnings from the machine shop into one bin, pass them through a magnetic separator, and melt them down with the aforementioned spillings, trimmers' scrap, etc., into ingots. The ingots are generally used for the lowest quality of castings, or at the best only in admixture to give a second or third-quality alloy. An undeserved stigma is attached to these borings; engineers will not recognise their value, and, as just stated, borings worth 10d. per pound are indiscriminately mixed with others whose value may not exceed 5d. A system of classification will meet that supreme test of all industrial operations "does it pay?" and meet it well.

Assume that the output be such as to give a return to the foundry of 15 hundredweight of borings per week; assume the value of these to be 10d., 8d., and 6d. per pound respectively, and also that equal quantities of each quality are produced. Under the conditions presently existing in many establishments these borings, mixed together and remelted in the foundry, would be valued in the form of ingot at 6d., or a total of £42.

If classified into their respective qualities:—

5	hundredweight at 10d. per pound......	£23	6	8
5	" " 8d. "	£18	13	4
5	" " 6d. "	£14	0	0
		£56	0	0

or a difference of £14.

The melting down in either case will be the same, and against the £14 there is the cost of classification, which should in no case exceed £2, leaving a clear gain of £12 on 15 hundredweight of borings. That the cost of this classification should not exceed £2 may be gathered from the fact that one handy-man can collect the borings from the machines before a change of work or different quality of metal is put on. Copper and white-metal borings or turnings are in the same manner taken away from each machine before changing work. The same man passes the borings through a magnetic separator and takes them to the foundry storage bins. In the foundry these borings are melted down as occasion serves, say in 2-ton lots in the air furnace, and the ingots used again in their respective qualities. The trouble expended on such a classification is fully and financially justified.

Many white metals used for lining-up bearings contain a minimum of 85 per cent. tin. These turnings, when separated, can be profitably used as a means of adding tin to an alloy, and alloys so made up give in practice good results. The dross and skimmings of the white-metal shop present another opportunity. This dross may be readily reduced at a white heat by means of charcoal and sodium carbonate, and will yield as much as 70 per cent. of metal consisting chiefly of tin and copper, with small amounts of antimony. If anti-friction metals containing lead are used, more or less lead will be found in this recovered metal. It is best worked down in fairly large quantities to obtain uniform batches, analysed, and subsequently alloyed with the necessary copper and zinc to make up a fair gun metal.

These examples are actual possibilities and they merely indicate in a practical manner the vast opportunities for intelligent and profitable application of metallurgical knowledge as connected with the alloys. Borings and turnings, slags, oxides, and ashes and even the very sand heaps of a brass foundry all offer problems that will yield profitable solutions.

What are the opportunities that lie within the grasp of the general iron foundry? Unlike the brass foundry, the metal is not the chief item; and though by methodical and intelligent mixing this can be considerably improved, it is obvious that the greater opportunities lie in the method of handling it, in the form of pig and when molten, in the methods of moulding, and in general foundry operations. Nothing unduly "ideal" or "classic" is here intended, and as evidence of this I will take as examples two typical iron foundries such as may be seen in any foundry centre in Britain and describe in part their working conditions.

1. A jobbing iron foundry, output 20 tons per week, consisting of a few specialities, builders' and street-drainage work, and general castings for the trade; heaviest casting about five hundredweight. The specialties are moulded from plates or in snap flasks. Cast-iron boxes are used for the plate moulding, joints not planed and hence seldom true; cast guides serve as pins and these are just as they have left the sand. It is no small wonder, then, that castings showing overlapping joints and varying in weight and thickness are made from the same plate patterns. The snap flasks are fairly good, but this is owing to the fact that necessity compelled their purchase from outside makers. The only work made in these flasks is of a simple and shallow character, nothing deep being attempted. In the general moulding boxes no apparent design can be detected; suitable patterns were not made to mould them from and they possess a hap-hazard "fit where they touch" sort of look. The moulding tools are on a par with the boxes, and necessities such as brushes, bellows, pails, rapping bars, rammers, shovels, etc., are noteworthy by their comparative absence. The sand mill is a relic from a dismantled mortar-grinding establishment. The cupola, also a second-hand bargain, is fitted with two tuyeres and the charges are carried onto the stage by hand. This may be a little out of date, but then the cupola was picked up dirt cheap, and though it may burn a little extra coke that item does not count for much in the long run; and as for carrying up the charges—well, unskilled labour is cheap enough anyway. Possibly!

A moulding machine is installed but not operated. The preliminary expense of this machine was met with pleasure, but the necessary accessories were fitted up on the cheap system. Moulding boxes were good enough without fitting, plates would answer quite well without any expensive machining up, and therefore the handy-man of the establishment prepared both the boxes and plates. This machine now stands in "icy isolation," a superb monument to the folly of the cheap system. The arrangement of the foundry is in keeping with the tools—no mechanical appliances of any kind, and every ounce of metal, every lift, is carried or performed manually. Boxes are stacked anywhere and generally in the most inconvenient places. Foundry supplies are equally inaccessible, and the moulders spend no inconsiderable time in searching for material. Add to this the fact that one end of the shop is open to all the winds of heaven, that coke, iron, scrap, sand, ganister, limestone, boxes—all form a hopeless chaos at this open end (which serves the double purpose of store yard and entrance) and we have a picture with a very telling moral. The method of working is equally hap-hazard; the moulds are slovenly made, put down in any corner that strikes the man's fancy; hence all classes of work are indescribably mixed and the appearance of the floor just before casting time is one of bewildering confusion.

The example quoted is not that of a foundry suffering from want of capital, nor yet that of an establishment making no profit, and many similar instances may be found amongst the jobbing foundries. If profits are made under these slothful conditions—and they undoubtedly are—then a most magnificent opportunity lies already at hand to increase these profits manifold. The immediate renovations in this particular establishment might be thus tabulated:

1. The installation of a quick-melting cupola, a blower of ample capacity, and the charging stage served by a suitable hoist.

2. The division of the foundry into floors suitable to various classes of work, and the equipment of each floor with the requisite tools and equipment to mould and produce clean, sound, economical castings.

3. Serving these divisions by a narrow-gauge track, the moulders on each floor taking their supply of molten metal from a "bull" ladle carrying molten metal along the tracks and supplying each section.

4. The adoption of convenient moulding boxes efficiently mounted and fitted complete.

5. Systematic group storage of these boxes in such a way that any one can be reached expeditiously. Neat and convenient storage of all foundry materials—the aim being to economise time and space.

6. Methodical management, powerful organisation, and the development of mechanical aids in moulding the speciality castings.

As a second example, a typical engineering foundry employing fifty moulders will be selected. This particular foundry is engaged in general engineering work and fairly good castings are turned out, but to get them costly and unsystematic methods are resorted to. On the cupola stage charges are not weighed, consequently the product is seldom uniform, and as hardness tests are not made nearly every cast varies, as the machine shop will testify. As in the first example, there is here a lack of system on the moulding floor. Loam, dry-sand, green-sand moulding, and core-making are mixed up to an unfathomable extent. To emphasise this further it may be stated that each moulder orders his own cores. It frequently happens that the cores are forgotten until the mould is made, and therefore cannot be finished until the cores are dry. If this happens near casting time, half-dry cores are put in and in the necessary rush vents are forgotten and the cores improperly fixed or centered. In order to get the top sides of castings to machine up clean, they are thickened to as much as half-an-inch above pattern size. The additional work thus thrown on the machine shop is not at all justifiable or in keeping with the spirit of modern founding.

Although many standard pieces are worked year in and year out, no plate moulding is adopted and mechanical aids to moulding are deemed unworthy of attention. The tools are scarce and inefficient, the stock of boxes being only sufficient to supply twenty-five moulders instead of fifty; hence many devices have to be resorted to in order to keep the men going. Boxes are split up—a top part to one, a drag to another, and so on. Patterns made for rolling over are bedded in the floor, and the best thing that can be picked up is used for a top part. This entails much cutting of bars, making of hangers to carry the sand, and an all-round addition of work and risk. This state of things is owing to the fact that the establishment in question is too busy to make any boxes and this has been the case for several years. There is a similar scarcity of general tools—this foundry in common with many others suffering from the absence of all system in storing either tools or material. One result of this lack of organisation is that a large amount of overtime is worked, by no means tending to economy.

Under this latter head may be found the weakness of this particular establishment—poor organisation. To remedy this, put the organisation and management on a footing in keeping with modern industrial progress, and an opportunity has been embraced that will materially affect improvements in quality of product and reductions in cost. No elaborate system is advocated, simply intelligent management, methodical division of work on the moulding floor, and systematic mixing on the cupola stage.

The advantage of an application of metallurgical science and the possibilities and benefits to be derived from an effective organisation have been dealt with in the brass and iron-foundry sections respectively. These opportunities, after adaptation to local requirements, apply equally to the steel foundry, special opportunities lying in the direction of increasing the reliability of cheaper or non-tested grades of castings, better designs of drying stoves and annealing ovens, and the introduction of sands and facings to resist the high temperature of steel and to give smooth, clean castings. The stringent specifications steel castings have to meet tend to keep the quality of tested castings ever on the upward grade. If the same care were devoted to the mixtures and melting of steels for non-tested castings as is shown to specification and forge qualities, then one cause of unreliability and failure in working life would be removed. It must be confessed that certain so-termed cheap qualities of steel castings are decidedly inferior, and in practice give results lower than, or at any rate, no better than would be obtained from malleable cast iron.

Steel mixing and melting demands the exercise of extreme care. This is recognised and met in a way that should convey a very telling object lesson to the iron and brass founder. In steel-foundry practice, the chemical and physical laboratory are recognised institutions and every advantage is taken of scientific assistance. Crucible-furnace mixtures are controlled and regulated by chemical analysis; the same factor controls the working of the open-hearth plant, and supplies with each cast a complete chemical analysis—that is to say, the content of carbon, silicon, manganese, sulphur, phosphorus and (differentially) iron in the product. This chemical control of composition, in combination with various mechanical tests of the material, keeps an efficient check on the quality and materially assists in the economical production of good castings.

The high initial casting temperature of steel necessitates the use of special moulding materials, and in this direction lies a large field for experiment. Naturally, a highly refractory material is required—one that will give a smooth and even skin and at the same time peel readily from the castings, in a similar manner to the way in which the facing sand peels from an iron casting. All moulds for steel castings, with the exception of those of light section, are stove-dried. In the matter of these drying stoves much improvement can be effected, for many of them seem to have been built with the sole idea of consuming fuel only. The design of a drying stove should be such as to dry quickly, thoroughly and economically,—conditions not hard to meet.

Steel founding offers fair scope for the development of machine and plate moulding, many articles, as for instance spanners, being of a repeat character. Other opportunities lie in the direction of adopting systematic methods in overcoming the effects of warping, piping, contraction and kindred evils.

From what has already been written it will be readily gathered that the greatest of all immediate opportunities lies in more intelligent and systematic organisation and management. The work of the foundry must not be unduly increased in order to save the expense of a few tools. On the other hand, there must be no needless accumulation of boxes, etc., of no further use than to fill up storage room. In this, as in all other cases, an endeavour must be made to strike the happy medium and to obtain the highest degree of efficiency at a minimum outlay. Subdivision of work has been spoken of, but yet further word may be permitted on this head. A moulder is profitable only while moulding, and therefore the aim of any system should be to save him all labouring or unskilled work, thereby benefiting the moulder personally and the foundry generally. This may be done by the judicious employment of trained labourers to knock out the boxes, prepare the sand for the moulders, and handle all materials and flasks. An extension of this principle results in the employment of a casting gang, a strong endeavour being made to keep the moulder at his legitimate business of moulding exclusively.

The equipment should be such as to occasion no waiting or searching for tools or materials. These conditions can be readily secured by the exercise of that invaluable industrial commodity—forethought. A good system of foundry stores, in conjunction with the plan of making the men responsible in a pecuniary sense for the tools entrusted to their keeping, will materially assist in effecting this result. The general equipment must be arranged to meet the particular need of each individual foundry, and this subject is one that will repay any amount of time and thought expended on it. Economical and efficient furnaces, ample power for handling boxes, metal, etc., and good facilities for the quick production of all classes of castings are a few of the essentials under this head. The metallurgical opportunities have been indicated in the remarks on brass-foundry practice and give full evidence of the advantage to be derived from a thorough application of metallurgy to all foundry work. The present position of chemical analysis in steel works is an indication of what the future holds for the iron and brass founder.

The opportunities here presented doubtless savour of the moulding floor and the sand heap, but experience firmly convinces that a proper management of that floor and suitable use of the heap results in large increase of efficiency and profit.

THE COPPER MINES OF ASHIO, JAPAN.

By Edwin G. Adams, Jr.

SINCE Japan abandoned its policy of isolation, under the instigation of Commodore Perry's fleet in 1853, the whole world has stood amazed at the rapid development of its latent resources; and in no industry has this development been more apparent than in that pertaining to mining. The gold and silver mines of the Island of Sado, the coal mines of Moji, the sulphur mines of the volcano of Atosa-nobori, and the copper mines at Ashio, have all been worked, according to authentic record, since earliest times by the primitive native methods; these have now given place to modern metallurgical appliances operated by native mining engineers educated in Japan.

The abandoning of the old methods has had its natural effect on the output of the mines of Japan; all metals, with the exception of iron, show an increased production since the beginning of the period of transition which may now be said to have reached its end. This increase is particularly well-illustrated by the statistics giving the annual output of the copper mines. In 1881 they produced 4,810 metric tons;

AN ADIT OF THE ASHIO MINES.

10,625 tons in 1885; 16,384 tons in 1889; and 19,814 tons in 1894,* and since then the production is said to show a still further increase, but no statistics are available. This output places Japan next to the United States, Spain, Portugal, and Chili as a copper producer. About one-third of this total is the product of the Ashio mines, which rank high in the list of the world's great copper producers. The Ashio mines were originally the property of the Japanese Government, and have been worked since the sixteenth century with an annual output never exceeding 300 tons; they are now owned and operated by Mr. Furukawa Ichibei of Tokyo, and under his efficient management the output has been largely increased until it has now reached the remarkable figure of 6,000 tons per annum.

ELECTRIC LOCOMOTIVES WITH ORE CARS.

The mines are situated 10½ miles south-west of Nikko, a place that few globe-trotters fail to visit, for here is located the most perfect assemblage of shrines in the whole land, combined with noble mountains, cascades, and monumental forest trees. The journey from Tokyo, or Yokohama, is made by train, the 91 miles taking most of one day, and the trip to the mines can then be made directly from Nikko by jinrickshaws. If the tourist is visiting Chuzenji (and this beautiful mountain lake is seldom omitted from the itinerary of the most hurried worshipper at the shrines) the inspection of the mines may be made on the return trip to Nikko; but this route is available only to pedestrians, as the path down the pass is cut out of the cliff sides or supported on plank bridges. Tea houses along the route exhibit beautiful specimens of copper pyrites, which are sold to the Japanese pilgrims on their way to the sacred mountain of Nan-tai-san overlooking Lake Chuzenji; and the traveller is also notified of his proximity to the copper mines by the tram cars passing through the street of Nikko, drawn by slow-moving bullocks, laden with copper ingots on the down trip and returning with fuel.

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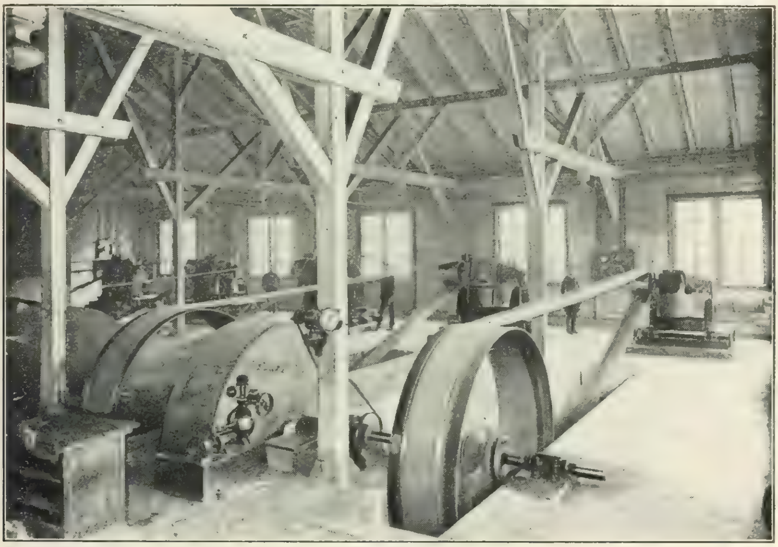
* *Résumé Statistique de l'Empire du Japan, Tokyo, 1895.*

The change of scene from Nikko, or Chuzenji, is complete. One leaves a land of peace with delightful surroundings and steps into the midst of a foul-smelling, smoke-laden valley where the bare red hillsides, denuded of all vegetation, present a striking contrast to the green hills at Nikko, with its world-famed avenue of cryptomerias, while the air vibrates with the clang of hammers and the throb of engines.

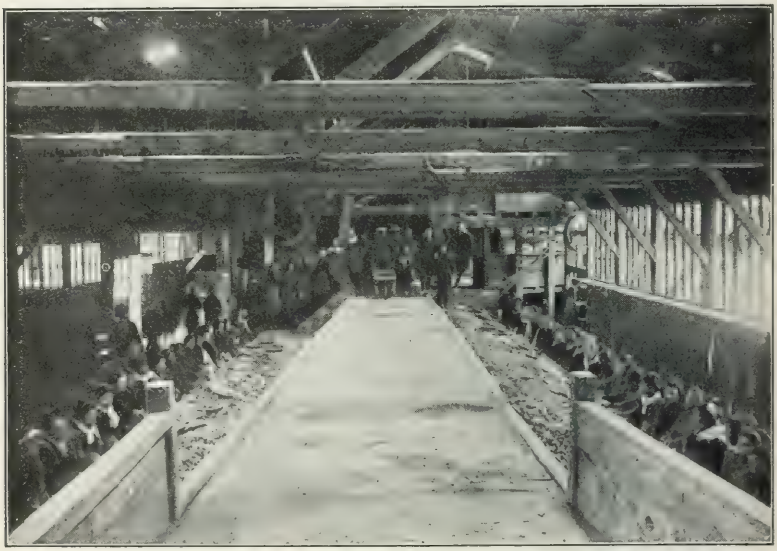


INTERIOR OF THE POWER PLANT.

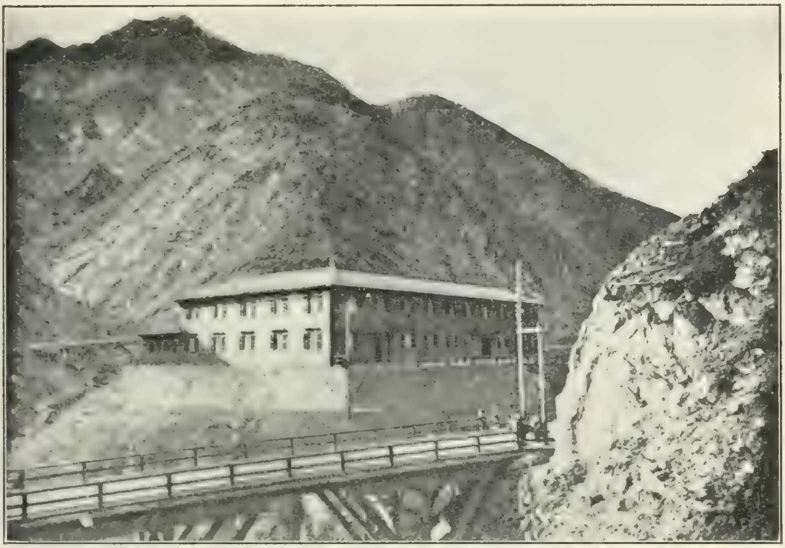
The mines are worked by adits located at the villages of Ashio and Kotaki; the former is the more important and is situated on the eastern side of the mountain, the latter on the western, but the two are generally spoken of collectively as the "Ashio Mines." The adits from the Ashio side are being pushed forward to meet those working from Kotaki, about 2½ miles distant, and at the present rate of working the mines will be exhausted in about ten years.

The village of Ashio, where the operatives have their homes, is separated by the Watarase-gara, a mountain stream running between steep banks, and spanned by numerous bridges, carrying the tramway and flumes. No two of these bridges are alike in design; in fact, it would seem as if the bridge engineer of the works had put into practical use all the available literature on bridge designing.

The total number of persons employed in various services at the mines and furnaces is about 10,000 and these with their families make up a small city of 17,000. Of these 75 per cent. have been born on the spot, as were their fathers and grandfathers, and some have never seen beyond the red hills which close in the village and mines. They are cared for by the proprietor, fed, and sent to school until twelve years of age. The village has a well-equipped hospital at which the operatives and their families are tended without charge. Only men are employed below ground to dig the ore, working in shifts of eight hours each, while those employed at lighter tasks work shifts of twelve hours. Women are employed at the light work, such as sorting and washing ore by hand, most of them being the wives of the miners. The average pay per day for those engaged in manual work is 13 cents in silver money and a stated quantity of rice and fuel, while the miners are paid by the quantity of ore extracted. The furnace and shaft men receive from 11 to 30 cents per day, and the women are paid 7 cents.



WOMEN SORTING ORE.



THE HOSPITAL.

The ore is almost entirely copper sulphide, although a small quantity of the oxide is also present, and it is worked from twelve veins from 3 to 6 feet in thickness. It carries about 19 per cent. of the metal, and the total output of sorted ore is about 100 tons per day. The treatment of the ore is as follows: The ore is sorted at the mines and divided

THE SCHOOL ROOM.

into two classes, the rich and the poor; the former is sent to the concentrating works, while the latter is resorted, crushed, and concentrated to bring it up to the same grade as the rich, after which the treatment is the same. This work is mostly done by machinery of German manufacture, although hand washing done by the women is still in use. The ore is roasted in brick reverberatory furnaces in which wood is used as fuel; it is then passed to the smelting furnaces, which are rectangular charcoal blast-furnaces, each having eighteen tuyères, constructed of wrought iron and protected by water jackets. The charcoal is made in the mountains close by by native burners, and is mixed with a small quantity of coke brought up from Nikko on the tramway. The flux—limestone—is obtained at quarries in the vicinity.

EXTERIOR OF CASTING HOUSE. IT IS BUILT OF SLAG BRICKS.

The product of these furnaces is black copper with a considerable amount of copper matte, assaying about 55 per cent. The black copper analyzes: copper, 96.014; arsenic, 1.226; iron, 1.361; tin, 0.692; lead, 0.428; sulphur, 0.337; bismuth, 0.112; silver, 0.014; cobalt, 0.012—total, 100.196.* The matte is broken up and remelted, after which it is put through a Bessemer furnace, each melt being 800 pounds, and the result is fine black copper which is said to be nearly pure. The copper is cast into rectangular ingots each weighing 58 pounds, rotating casting tables with cast-iron moulds being used.

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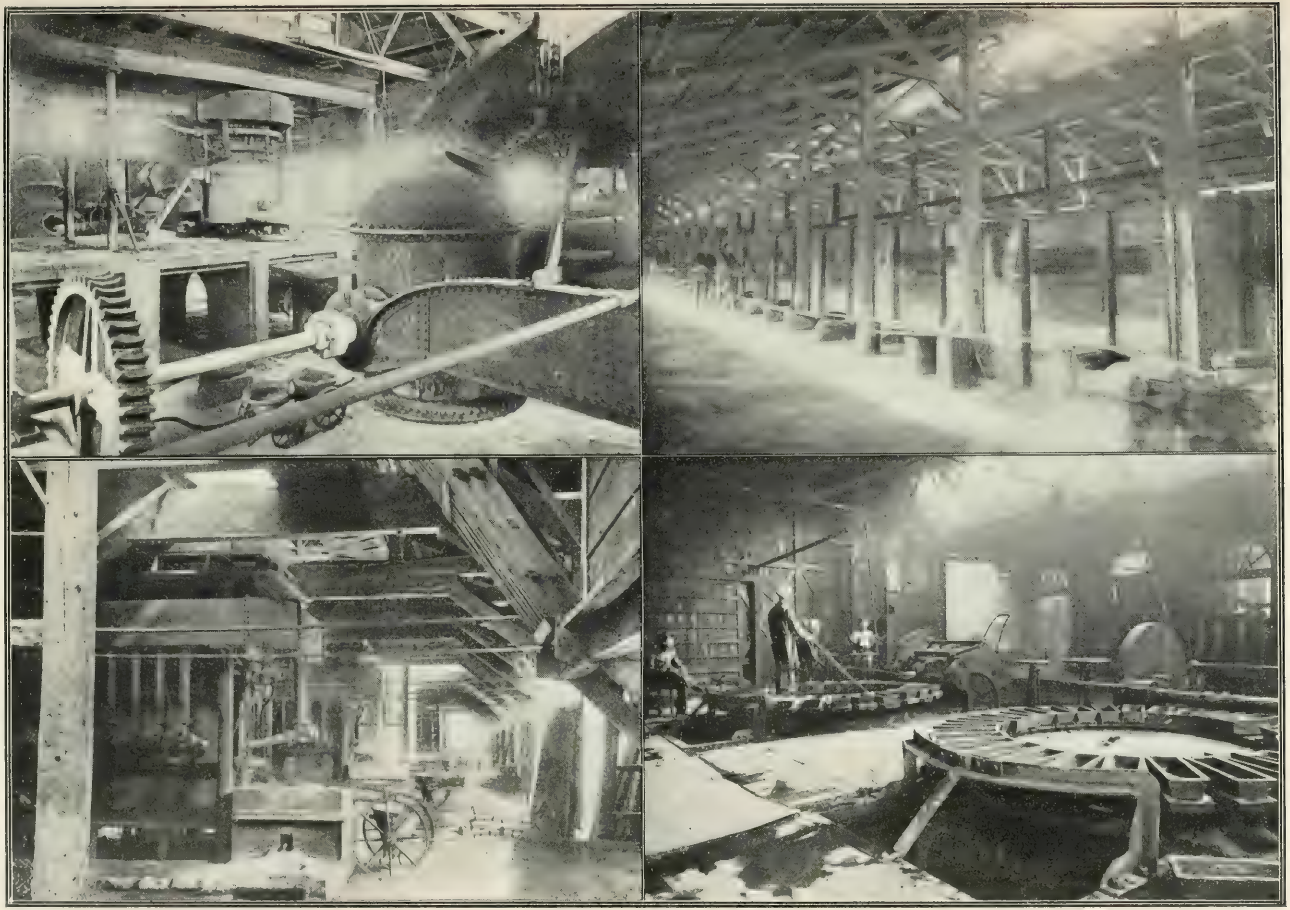
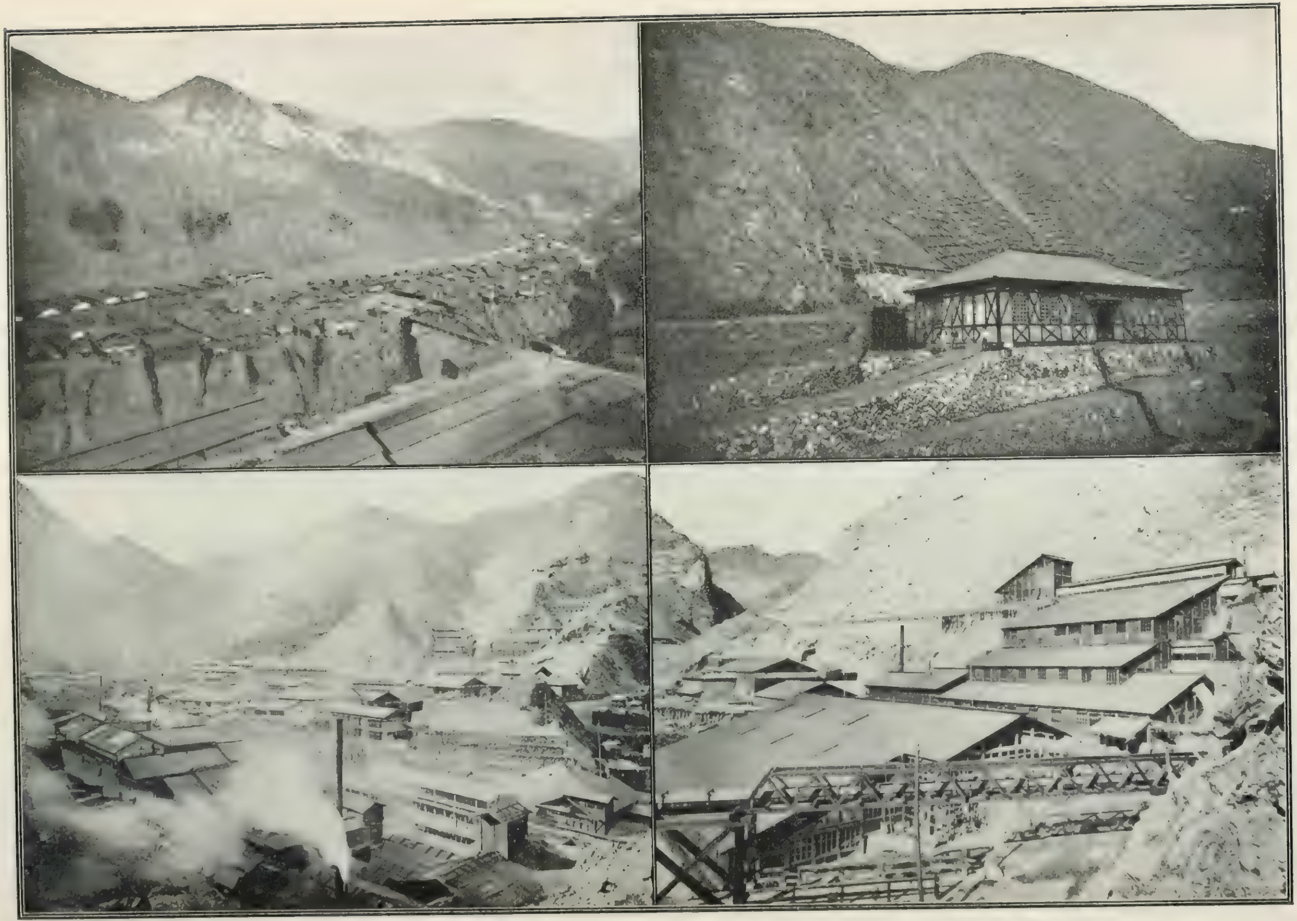
* *The Engineering and Mining Journal*, August 6, 1892, paper by Mr. W. J. Menzies.



Bessemer Plant for Copper Matte.
Interior of Smelting Plant.

The Roasting Furnaces.
Casting House, with Rotating Casting Tables.

VIEWS IN THE ASHIO COPPER-REDUCTION WORKS.

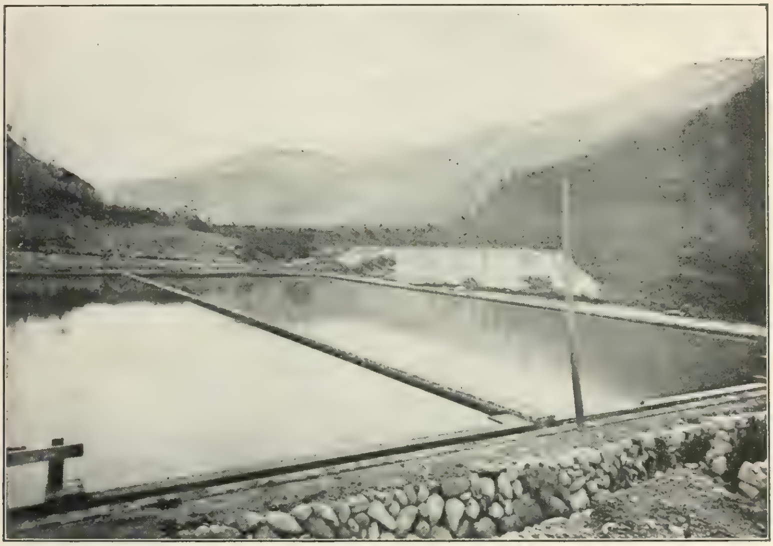


Village of Ashio. Part of Works in Foreground.
General View of the Works.

Protection Work on the Hillside.
General View of the Works.

THE ASHIO COPPER WORKS AND THEIR SURROUNDINGS.

Originally the water from the ore-washing plant, as well as the slag, was run into the Watarase-gara, but owing to the damage done by this poisonous discharge to the crops in the valley below, where the water is used for irrigating, and the subsequent agitation amongst the farmers living along its course, a series of settling tanks and filters have been fitted up for the purification of the water before it is allowed to enter the stream. Powdered lime is added to the water as it is run into the settling tanks, and after settling the water is filtered through sand beds. A large sum of money has been spent on this purification plant, and the result is said to be in every way satisfactory.



THE FILTER BEDS.

Another protection which it has been found necessary to inaugurate is the construction of basket work on the hill sides, on which there is absolutely no vegetation, to prevent the soil from being washed down into the village during the heavy rains which prevail during the months of July and August. This basket work is constructed of the small branches of trees twisted together and held in place by stakes driven into the ground; it has the appearance of a huge fishing net laid out on the hill to dry.

The river furnishes at all seasons an abundant supply of water, which is led by wooden flumes down the valley from the intake several miles above the works. One mile below the works is the power plant where 200 horse power is developed by Pelton water wheels and used for electric lighting of the village and works, driving motors, etc.

Electric-motor cars are used about the works and mines for hauling ore, etc. Thirty miles of narrow-gauge track is operated to Nikko, where the ingots are taken for shipment, and into the surrounding country for bringing in charcoal and limestone; but on this either the small native pony or bullocks furnish the motive power. Over the Hoso-o pass on the line to Nikko a cableway three miles long has been constructed, which consists of a steel-wire rope supported on wooden towers and revolving on cast-iron drums at each end. The load, consisting on the descending line of copper ingots and on the ascending of bags of charcoal and coke, is suspended from the cable by wrought-iron hooks which are fastened to the cable by wire bands. At some points the line is several hundred feet above the surface.

Low wages combined with abundant fuel and flux at hand permit the production at a moderately low cost. About 80 per cent. of the output is exported, China and Korea with their copper coinage being the largest customers, but it is brought into competition with American and European copper at Hong Kong, England, India, Australia, and Germany.

The mines are entirely under Japanese management and furnish an excellent example of the progress these people have made in the arts as well as of the willingness and ability of the native workmen to use new tools. The mine officials are most courteous to visitors furnished with proper letters of introduction, and the trip is to be recommended to those engineers contemplating a journey amongst the gentle Japs.

NOTE: The author wishes to express his obligation to those officials of the Ashio mines who kindly furnished him with the information which forms the basis of this paper and for the photographs used in illustrating it.

THE INDUSTRIAL APPLICATIONS OF NICKEL STEEL.

By Charles Edouard Guillaume.

One of the noteworthy subjects of the day in engineering work is the progress which is daily being made in the knowledge of alloys of various metals, and among these researches none has been more interesting than the work of M. Guillaume upon the nickel steels. The results of his investigations have formed subjects for important discussions of the French Academy, while apart from their interest to the student of pure science, they have found immediate and important practical applications. M. Guillaume here gives the results of his own original and noteworthy work, and makes some conservative predictions as to future extended applications.—The Editors.

THE present epoch, according to some writers, may be called the age of steel, and indeed we may follow the example of an earlier period, the age of stone, which was separated into the periods of chipped stone and of polished stone, and divide the present age into the period of carbon steel and the period of special steels.

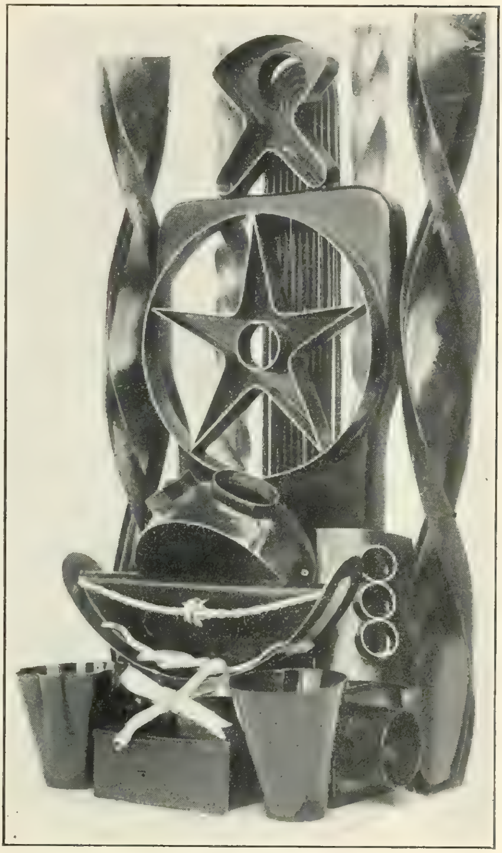
There are many materials which have been systematically alloyed with steel to communicate to it the most diverse properties: chromium, manganese, tungsten, vanadium, aluminum, silicon, copper, etc., have been employed, but none of these has at the present time the importance of the alloy of steel and nickel. There are many reasons for this, of which we may mention the relatively low price of nickel, and the immense diversity of properties it is capable of communicating to steel.

For a number of years nickel steel has acquired celebrity because of its extensive use for military purposes. It might be considered desirable to give much space to the consideration of this phase of the subject, but it is so extensive, and also relatively so well-known, every popular journal having been filled with illustrations of armour plates and projectiles in all stages of resistance or demolition, that it has appeared more advisable to make a brief historical examination of the general subject of nickel-steel alloys, and then a more special study of the recently discovered alloys and their industrial applications.

There is no definite record of the first attempts at the manufacture of ferro-nickel. Such alloys are by no means recent, however, for if we ignore the discovery of certain meteoric irons containing nickel in an imperfect state of alloy, we find in 1820 the first authentic traces of a rudimentary manufacture of some bars of ferro-nickel. Nearly a third of a century later there were exhibited at New York, by Mr. Thurber, a number of specimens of ferro-nickel, but it was not until another generation had elapsed that the true industrial importance of nickel steel began to appear. It was in the development of armour plate that nickel-steel first attracted attention, and for a time the superiority of the projectile was replaced by victories of the armour, although the development of modern high-power guns has again restored the superiority of the projectile. In this work the use of nickel extended to but very small proportions, the alloy acting to modify the properties of the steel without entirely transforming them. An addition of but 2 per cent. of nickel suffices to produce appreciable effects, and with the use of 5 or 6 per cent., or in rare instances to 10 to 12 per cent., the maximum effect in the direction of mere improvement in the steel for armour plate is reached. With further additions of nickel the phenomena at first become confused, and then acquire distinct peculiarities. As the proportion of nickel approaches 25 per cent. new properties appear, and as the nickel content is further increased these are again changed, the alloy departing further and further from the nature of steel, and acquiring properties which are both surprising and inexplicable. But before pursuing this subject further we must devote some space to nickel itself.

It was in 1751 that the Swedish chemist Cronstedt discovered nickel in a mineral which until that time had been worked for copper alone. For a long time it was produced in but small quantities, the supply coming altogether from the German and Norwegian mines, and it only began to assume industrial importance upon the discovery in New Caledonia by Garnier of the mineral which has been named Garnierite. A French company, formed in 1880 by Mr. John Higginson, began the development of the mines in New Caledonia, and the price of the metal, which had previously been about 25,000 francs per ton, fell to 5,000 francs.

Since that time the price has been somewhat lowered, partly because of the opening, in 1890, of the mines in Canada. The lowest commercial price in Europe has been about 3,000 francs per ton, but nothing is more significant of the increasing importance of the metal than the fact that the price has gradually risen in recent years more than 30 per cent., in the face of a continually increasing production.



SPECIMENS OF NICKEL-STEEL PRODUCTS.
An exhibit at the Paris Exposition showing the extreme ductility and toughness of the various alloys.

The most important producer at the present time is the French company "Le Nickel," of which the output has risen from 400 metric tons of 2,208 pounds, in 1890, to 4,000 tons in 1900. The English company "The International Mining Company" recently formed to re-work the mines already developed in New Caledonia, holds the second place. The Canadian mines, which in 1891 showed themselves strong competitors of the mines of New Caledonia, and of which the production rose in two years from 300 tons to more than 2,000 tons, will probably have some difficulty in maintaining their position when modern methods of mining, transport, and treatment shall have been installed in the great island of the Pacific.

The ore found in New Caledonia is twice as rich as that of Canada, but the transport must be effected to the harbour from the mines on the backs of men, and the ore shipped to Europe for reduction. When, by the introduction of railway or cableway transport, the cost of handling shall be reduced, and the ore subjected to a preliminary treatment before shipment, we may expect that New Caledonia will become almost the sole source of supply of nickel for the whole world.

Let us now return to the study of the properties of nickel steel, properties so peculiar that Mark Twain himself might almost have invented them.

The first and most striking thing observed by the producers of nickel-iron alloys was the fact that with a ferro-nickel containing about 25 per cent. of nickel, two of the most magnetic substances known formed an alloy almost as insensible to the action of a magnet as copper. Since this combination almost completely nullifies one of the most characteristic features of both constituents it is natural to expect decided modifications of other properties. A still more singular fact appears in the discovery that the magnetic properties of the constituents may be conferred upon the alloy by subjecting it to great and rapid cooling. By the addition, however, of chromium, carbon, manganese, etc., the non-magnetic alloy may be rendered much more stable in this respect, so that it retains its properties, even after chilling in liquid air, or after the most severe mechanical treatment. We thus have a soft, and at the same time very tenacious metal, susceptible of a great number of useful applications.

Let us examine at more length this alloy, which attracted especial attention of metallurgists at the recent Paris exposition, and of which examples were shown by nearly all the important French establishments.

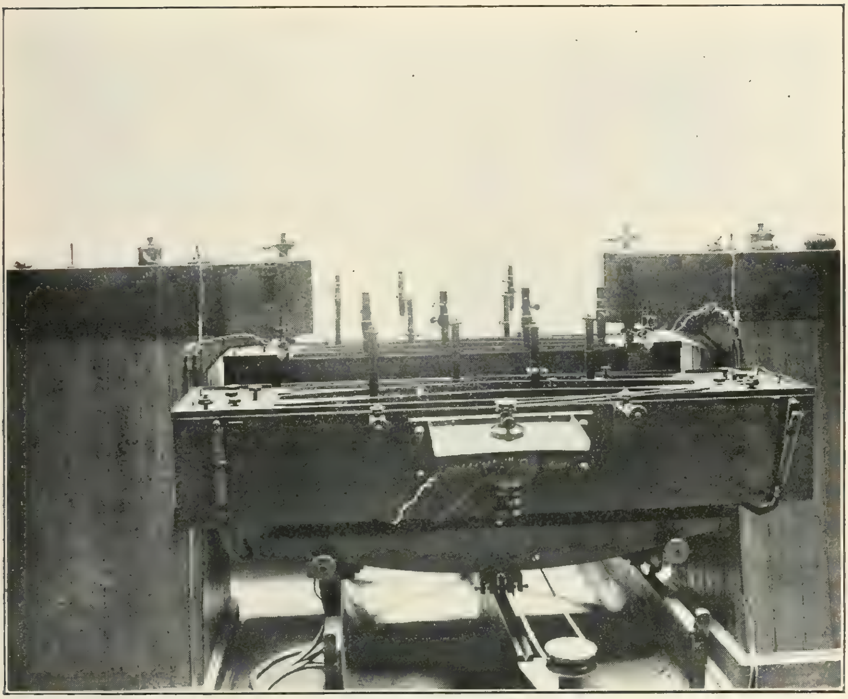
Tests made of these alloys, more or less modified by additions of other elements to be mentioned hereafter, but all containing about 25 per cent. of nickel, give the following average results:

Resistance to rupture. . . .60 to 100 kilogrammes per square millimetre
(85,000 to 142,000 pounds per square inch.)
Elongation. . . . . .100 to 60 per cent.

A high degree of elongation generally corresponds to a low resistance to rupture, in such a manner that the total work required for the separation of the test specimens is sensibly the same. The above loads for rupture are low in comparison to those for carbon steels, but it must be remembered that the reduced section of the ferro-nickel at the moment of yield is only about one-half that of the original cross-section, so that the actual load per unit of section is doubled, while the remarkable degree of elongation gives a work of rupture higher than that of any metal which has yet been investigated.

Other examples of the tenacity of the alloy are found in the tests at Imphy, where a test bar was elongated 242 per cent. by ten successive tensile loads, the piece being annealed between each load; also, where bars of 10, 12 or more millimetres square were bent close upon themselves without showing the slightest crack.

The industrial characteristics of these alloys, then, are found in their remarkable tenacity, and in the possibility in subjecting them, without



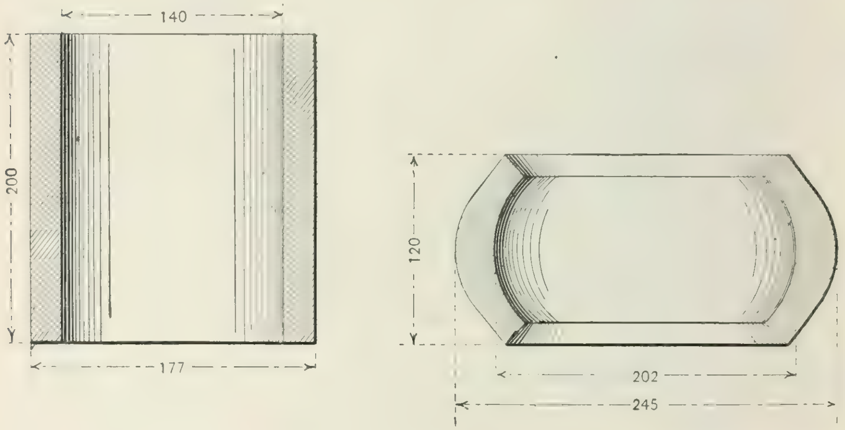
THE COMPARATOR OF THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES, PARIS.

Used by M. Guillaume in his researches upon the expansion of nickel steels.

injury, to deformations under which other steels would certainly show ruptures. When to this is added the fact that they can in no sense be termed soft, having an elastic limit fairly high, often reaching 40 kilogrammes per square millimetre, (57,000 pounds per square inch); that they present no especial difficulties in forging; that, although hard, they are readily worked in the lathe or planing machine, one can form some idea of their industrial future.

I have said of their future, for we are far from having availed ourselves yet of the valuable mechanical properties which these alloys offer to the engineer. From this point of view, the Exposition of 1900 was characteristic; it showed in profusion what might be accomplished with these alloys, but at the same time gave very few examples of what had already been done with them. This task will be that of the approaching years, and the best proof of the important applications which are to be expected is that the greatest establishments, such as Creusot, Chatillon, Commentry, Commentry-Fourchambault, attracted attention by the remarkable exhibits of the products of their forges by specimens showing the texture of the metal and the lines of deformation, or as a more popular illustration, by a serpent as thick as the arm of a child, tied in a complete knot while cold. This and a number of other examples are shown in the illustration. Page 81.

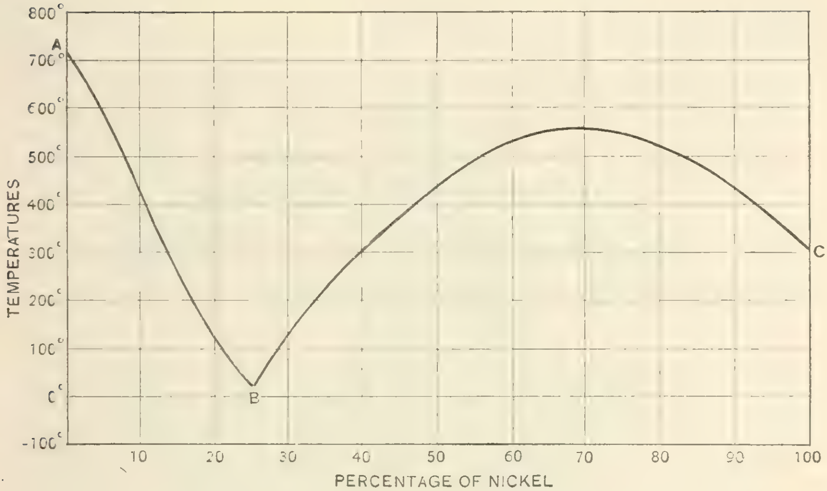
Nevertheless some applications have been practically realised, notably in military work, where the relatively high price of these alloys plays a secondary part. Armour plates, gun shields, and hoops of various kinds to serve as reinforcements to the shocks of projectiles or the bursting of pieces of artillery, have been constructed. An example of such work is seen in a hoop made by M. Jacob Holtzer, which was subjected to the following test. The test piece was a cylinder 200 millimetres in height, 177 mm. in external diameter, with walls 11.5 mm. in thickness, and being subjected to a load of 900 tons (metric) it was reduced to 120 mm. in height. The extension of the interior fibres attained 46 per cent., without the formation of fissures of any sort.



TOUGHNESS TEST OF NICKEL STEEL.

The hoop shown in section on the left was compressed by a load of 900 tons to the shape shown on the right, without showing any cracks.

Returning to the scientific study of the alloys, if we increase the content of nickel we do not find more than one of the various characteristic peculiarities at any given temperature; each alloy possesses, on the contrary, at a determinate temperature, certain definite, physical properties. Thus we have alloys which at ordinary temperatures are non-magnetic, but which become magnetic when cooled; but when the original temperature is restored the magnetism disappears. As the



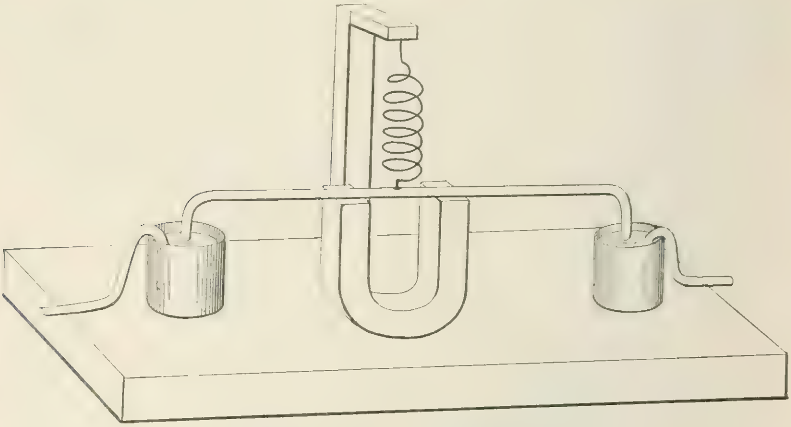
MAGNETIC TRANSFORMATIONS OF NICKEL STEELS.

Showing the temperatures at which they become magnetic upon cooling.

content of nickel is increased the temperature at which the magnetism disappears is elevated, and may attain or pass 400° C. A clear idea of this phenomenon and of those which have already been mentioned, will be obtained from the diagram above.

The curve A B C represents the temperatures at which the alloys become magnetic upon cooling; and we see that while in the portion A B they retain their magnetism in retraversing the curve of heating, they lose it in traversing the portion B C, this part representing the alloys containing from 25 to 100 per cent. of nickel.

This variation in magnetism of nickel-steel alloys of the second category may be utilised in several ways. The loss of magnetism by reheating being gradual, and not abrupt, such alloys may be used as magnetic indicators of temperature changes. I myself have also used them in the construction of an automatic circuit-breaker, operating in a very positive and satisfactory manner and continuing indefinitely operative. The principle of this apparatus is shown in the sketch, page 86. A wire of nickel steel, containing, for example, 30 per cent. of nickel, has its ends bent down into two mercury cups, so as to form a portion of the circuit. It is subjected to the upward force of a spiral spring, and to the downward attraction of a permanent magnet. If now the wire becomes heated by the current above a certain temperature, it loses its magnetism, and the attractive force of the magnet no longer affecting it, it is raised by the spring and the circuit is broken. When



A NICKEL-STEEL CIRCUIT BREAKER.

The nickel-steel wire, when heated by the curent, becomes non-magnetic, and is lifted by the spring, breaking connection with the mercury cups.

the wire is cooled its magnetism returns, and it may be replaced at will. This apparatus possesses several advantages over fusible wires. The connection may be immediately re-established, its action is always the same, and by the selection of a suitable alloy and a spring of proper strength it may be given any desired degree of sensitiveness. For example, I have constructed a circuit-breaker of this type which responded very exactly to a current of 0.4 ampere. The straight wire may, if desired, be replaced by a spiral of fine wire.

The most singular properties, however, of the alloys of this category are those relating to dilatation. No matter how small they may be, the dilatations of metals make themselves felt in a great number of cases. Without mentioning the important subject of measures of precision, it is only necessary to refer to the spaces left between the rails of a track, to provide for the expansion due to warm weather. It is also well-known that all large metallic structures must be provided with means to permit expansion and contraction, due to changes in temperature. An idea of the magnitude and character of expansion may be obtained by the use of a simple apparatus, composed of a cast-iron base, 40 to 50 centimetres long, carrying two posts, one of which serves to hold one end of the bar under investigation, while the other is finished to a smooth plane surface. The only additional apparatus required is a burner, and a sheet-metal shield to protect the bars of metal from the direct action of the flame. As an indicator a pin may be used, this being introduced between the finished surface of the post and the bar under examination, a piece of straw being gummed to the pin. As the bar expands under the action of applied heat, the pin rolls between the under surface of the bar and the top of the post, and the movement is so magnified by the piece of straw as to be plainly visible. If the expansion of one bar is known, the relative expansion of another may be measured by the relation of the angles described by the two pieces of straw.

Such an apparatus is necessarily very crude. For very exact determinations I have used the comparator by means of which the prototype metric standards were investigated before being sent out to spread the use of the metric system through the civilised world. Page 83.

This apparatus consists of two fine microscopes supported upon stone piers, by means of which very precise measurements of the variations in length of bars placed between them may be made. The bars may be placed in a trough filled with water, this permitting a determinate temperature to be very exactly applied and measured. In an instrument of this sort the errors of measurement never reach the thousandth part of a millimetre, while the precision of the temperature measurements is relatively still closer.

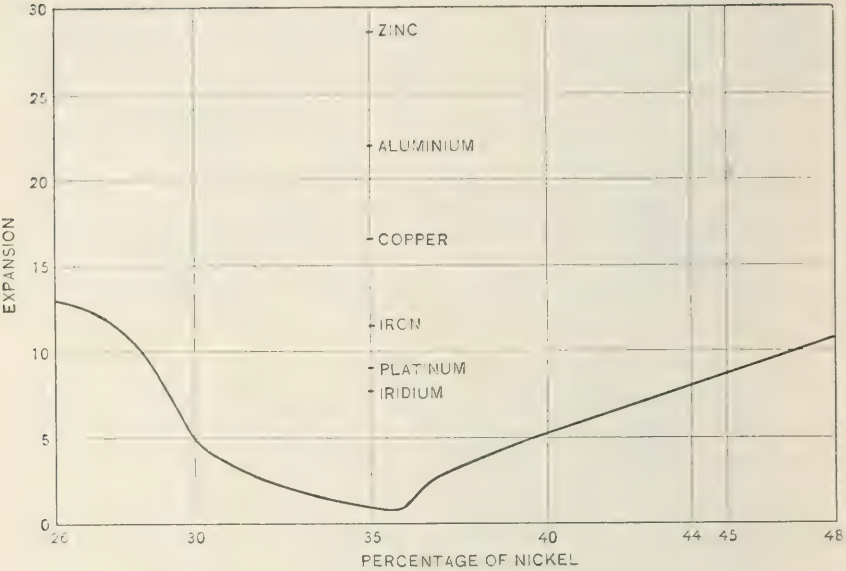
By the use of this instrument it has been possible to determine the expansion of a great number of nickel-steel alloys, and to represent the relative expansions in the form of a curve in which the expansibility is shown as a function of the content of nickel. Page 88.

The other indications on the diagrams give the expansion of various metals, from iridium, the least expansible, to zinc, the most expansible of the industrial metals.

We see here the singular fact that there exists among the alloys of iron and nickel one which has but one-tenth the expansibility of platinum, and one-thirteenth or one-fourteenth the mean expansibility of iron or of nickel.

This fact is proven beyond doubt; it will probably take years of study and investigation to discover an explanation of the observed facts, and physicists of the present day are by no means in accord concerning the theory involved. I shall therefore make no attempt to discuss this side of the question at this time, but rather consider the practical applications which may be made of these singular facts.

If nickel should ever reach the price of iron, which can hardly be hoped, the nickel-steels of minimum expansibility would immediately assume a colossal importance. Since these alloys are at the same time very tenacious, relatively soft and easily worked, and so little



EXPANSION COEFFICIENTS OF NICKEL STEELS.

The ordinates give the coefficients of expansion for 1° C. to the sixth decimal place. Note the very low expansibility of the 36 per cent. alloy.

oxidisable that they may remain immersed in water for weeks without showing anything but minute specks of rust, it is evident that they possess all the advantages of ordinary steel for structural purposes, together with other most desirable properties.

But without dreaming of the future, and limiting the applications of these alloys to their immediate conditions, we have special uses in horology, and in measurements of precision. In horology the application has already been made, since a large number of makers in various parts of Europe have abandoned the old-fashioned gridiron or mercury compensating pendulum, in favour of a simple rod of nickel steel, carrying a bob of brass or iron, the expansion of the bob alone being amply sufficient to compensate for the very slight expansion of the rod. Pendulums of this construction are in use to-day in a number of observatories, with excellent results.

In geodesy also there has been no delay in the use of the new alloys. In all geodetic measurements made at the present time a very high degree of precision is demanded, and it has been found very difficult to obtain satisfactory temperature conditions. Two systems have been employed in the measurement of geodetic base lines. The first, which is very precise, consists in carrying over the line a heavy standard bar, four or five metres in length, together with a mass of *matériel,* including trestles, microscopes, telescopes, etc., in a word, in traversing the line with a portable observatory. In the United States, this has even been carried so far as to provide for the surrounding of the bar with a jacket of ice, in order to maintain an invariable temperature. By the use of the new alloy all these precautions become unnecessary, without affecting the accuracy of the work.

The second method of measuring base lines is much more rapid; it consists in the use of measuring wires, 20 or 24 metres in length, subjected to uniform spring tension, and stretched from trestles placed on the line of the base. In this method the determination of temperature is much more defective, and appreciable errors occur. By the use of wires made from the non-expansible alloy, however, this rapid method is given a degree of precision to which it could otherwise have made no pretensions. Experience has shown that the nickel-steel wire method of measurement bears out the theoretical predictions. In the important expedition of Russian and Swedish savants to Spitzbergen, all the bases were measured with nickel-steel wires, and the precision attained exceeded all expectations.

When a non-expansible metal is spoken of, it at once suggests applications to scientific instruments and apparatus, in which such a material immediately removes all the errors which for more than a century have been combatted by the use of complicated and difficult constructions. Even if it is not yet possible to realise the advantages of a non-expansible alloy in large metallic structures, such a material need not be considered as banished from all practical work. I have already spoken of its use in connection with the construction of astronomical clocks, and it is applicable to ordinary clocks as well. By means of the use of this alloy in the construction of the balance wheel for the marine chronometer, practically all the errors due to changes of temperature are eliminated, thus affording the most simple solution possible of a problem which has occupied the attention of the most eminent horologists for centuries.

Again it is impossible to compute the number of accidents which have occurred by the rupture of steam-boiler tubes, due to the difference in expansion between the tubes and the shell to which they are secured. Many lives have been lost and much suffering caused by the ruptures which have been caused by this action, permitting torrents of scalding water to be poured upon the attendants.

Already Mr. Yarrow, the well-known constructor of marine water-tube boilers, has called attention to the importance of nickel-steel tubes because of their resistance to corrosion. Nevertheless Mr. Yarrow has considered but one side of the question, and in relieving the liability to rust he has produced unfavourable conditions by using a nickel-steel alloy which has a high expansibility. By selecting the proper alloy it is possible to remove nearly all liability to corrosion and at the same time to avoid the strains due to unequal expansion and contraction, thus greatly diminishing liability to accidents.

In this rapid review of the properties and applications of nickel steels, it has been possible to glance only at the many points which might attract attention. To what are these singular properties due, unknown as they are to any other combinations of metals? How can we explain these multiplex transformations? These are questions of the highest importance in the study of alloys in general, and of steels in particular. The problem is but partially solved at the present time, and yet it already begins to throw light upon the general subject of the nature of steel.

As for the industrial applications, without attempting to enumerate or predict all, one may at least affirm that nickel steels of various composition will become more and more used in all cases in which, by a greater or less increase in the price of the product, one may make use of a metal of the highest degree of security, of the least susceptibility to corrosion, and of the maximum durability. When, in addition to these conditions, the properties of magnetism or of expansion and contraction enter into question, nickel steel will meet the utmost demands of the engineer.

THE WORKING ECONOMY OF THE STEAM BOILER.

By Charles Arthur Hague.

Misunderstandings cause more trouble than misintentions, and anyone who aids in bringing the two parties to a contract nearer to a point of mutual comprehension renders a service. Their bargain stands firm and satisfactory to each, because both agree as to what each had agreed to. It is in this spirit that Mr. Hague discusses the purchase of a steam-boiler installation. He does not at all criticise the "expert test" *per se,* but merely points out that the results of such a test are generally to be regarded as a standard of comparison, not necessarily a standard of daily performance. To make the comparative performance standard, conditions must be brought as near absolute perfection as possible to eliminate all uncertain factors; and this is the avowed purpose of the expert test. Such conditions may not be economical in regular working, but the records obtained under them afford a basis for judging the work of the plant from day to day, and also for comparing it with other installations. So understood by both sides, it becomes a datum of value to the owners and can no longer be a cause of disappointment or contention.—The Editors.

EVEN though the number of different kinds of steam boilers does not amount exactly to legion, there are nevertheless very many of them, and the characteristics of economy, safety, danger, high and low cost, and other features, go to make up a subject of great interest to the designers, buyers, and users of steam generators. There are horizontal return-tubular boilers, locomotive boilers, water-tube boilers, plain cylinder boilers, vertical tubular boilers, and various patented but indescribable boilers of all kinds and patterns, all of which have their advocates more or less sincere and more or less interested in the commercial success of particular types, as well, of course, as the advantages to the buyers.

The proposition seems simple enough to provide a steam boiler for any particular use—a water-tight and steam-tight vessel, arranged so that it may be subjected to the heat of the combustion of some kind of fuel and so generate steam. But with all its seeming simplicity, there is plenty of room and opportunity to go wrong with the proposition and get into all sorts of disputes as to the various results really obtained, kinds and mixtures of coal, manner of firing, and general manipulation or special management of the boiler, steam, or fuel. Sometimes when one boiler is bought and installed there seem to be in reality three of them; one boiler the way the boiler-maker thinks it is, one boiler the way the buyer thinks it is, and one boiler the way it really is. What we want to know in any certain case is that form, proportion, etc., of boiler which will give the best efficiency and economy as a steam producer, secure the best conditions for operation with the given sort of fuel, the expected manner of firing, and the customary working conditions of the plant generally.

In determining upon the type, size, capacity and other items, it will be seen at once that two distinct lines of consideration are open, and experience proves that misunderstandings and differences of a serious nature, sometimes amounting to law suits, not infrequently follow uncertainty as to which line is to be followed. These two lines are indicated by the boiler-maker's point of view, and the buyer's or user's point of view. The boiler maker follows certain lines, sometimes comparatively arbitrary, basing his conclusions upon what he has been in the habit of doing in his boiler business and wants to continue doing in the future. The buyer is principally interested in knowing how much steam he can make, and how inexpensively his steam can be produced by the use of the coal he can buy in the market to the best advantage at his particular location. A failure to state in a boiler contract which line is to be followed, or a refusal to follow the line so selected, by either party thereto, will generally be productive of disagreeable consequences.

The boiler maker wants his boiler tested by some particular or standard kind of coal, regardless of its price and of whether the user wants to buy such coal or not. He wants this particular kind of coal manipulated and handled by the most skilful expert fireman he can scare up and put at the task, regardless of this expert fireman's pay, even though it may be double what real economy of regular operation could expect or enjoy; the expert fireman's sole aim being, for a very brief period of time, to secure the highest and best rate of combustion of the selected fuel. For this test the boiler maker wants his boiler cleaned and scraped inside and out, sometimes even claiming the privilege of stopping at any time he thinks cleaning ought to be done during the test. He wants his boiler operated at a rate best suited for making the best showing, regardless of regular working in everyday performance. In addition to all this, there are certain preparatory runs and some preliminary groomings desirable—then a certain manipulation and stage of the fire at the commencement of the trial run or test—then the special operation of the boiler by the skilled attendant during a specified time, usually twenty-four hours. Finally, at the close, the fire again carefully manipulated and brought as closely as possible to the condition observed at the start.

The buyer's "test" is very different and very simple, consisting in working the boiler in the manner ordinarily followed in everyday operation, by the regular attendants, with the coal burned and the steam made carefully noted; this regular running of the plant including the usual methods of firing.

Of course, a steam user ought to know and insist upon the best average work to be obtained for fair wages, and the most economical coal, all things considered, to be had in his locality. There are no objections to testing a boiler under expert conditions, especially if the test is standardized, as it will then be placed upon a basis for comparison with the work of other plants and a valuable insight will be obtained by the user as to what his boiler ought to be doing. The main trouble to be avoided is the installation of a boiler capable of generating the required weight of steam per hour *only* under expert conditions, and not able to do the required amount of work under the everyday conditions; close competition under too open specifications will sometimes lead to such mistakes, and, with adequate "jockeying," the boiler will appear to come up to the economy and capacity specified in the contract; but when the buyer protests and talks about rejection, his legal adviser will perceive and tell him that the contract he has signed does not deny to the boiler maker the right to do as he has done in making his test.

But the steam user can not hope ever to reach expert results in regular work. All he needs to know or to do, in buying his boiler, is to understand clearly from which point of view he is looking at the contract before he signs that instrument, and then he will be saved the mortification of having the boiler maker ring in an expert test upon him and obtain results thereby which ought to be at least approached under ordinary conditions. If he does buy boilers to be tested under expert conditions, he has only to insist that they shall make as good a showing as other boilers of the same type and size under like conditions; then he may rest assured that he must obtain the highest practicable percentage of the expert results in everyday work. The main thing, after all, to look out for, is that we generate at least the actual amount of steam needed, under ordinary conditions of service; for without this, the excess shown by the expert test will avail nothing. And this suggests an axiom recently coined by the writer:—

"An excess of steam made one hour is of no use during an hour when the supply is short."

Steam is elastic, but not to such an extent as this; boilers are sometimes made so closely for their work that during an expert test the fire and feed water can be manipulated so that a fat fire one hour may be burned down to a thin fire another hour, and, although the average of the run may show full capacity of steaming, many of the separate hours can be picked out during which a serious percentage of shortage occurred. A boiler should not be figured so closely that its so-called excess capacity must be called upon for regular service.

When it is known that the enormous sum of nearly $600,000,000 is annually expended for steam coal, in the United States, it is not difficult to comprehend the importance of proper and efficient methods in the construction and operation of boilers. And if these figures are not sufficiently respectable, it may be considered that at an average evaporation of eight to one, the weight of water annually turned into steam amounts to more than 3,200,000,000,000 pounds, or 1,600,000,000 tons. But these figures relating to distinct elements, as they clearly do, suggest at once that the generation of steam, or, in other words, the useful operation of steam boilers, should be considered under two heads largely independent of each other in character, but at the same time co-relative in the sense of working together towards a common end. These two heads are:— the proper combustion of the fuel in the boiler furnace; and the absorption of the resultant heat to the greatest possible extent by the heating surfaces of the boiler. They are entirely different in principle, because combustion differs from absorption; but nevertheless co-relative and inter-dependent in a boiler because the action and rapidity of absorption influences and modifies the rate and manner of combustion, while the degree of intensity in the combustion directly affects the absorption of heat.

A brief tangible statement with definite amounts would be say, 14,500 heat units developed by the combustion of one pound of coal; and the absorption by the water in the boiler through the medium of the heating surface of say, 80 per cent. of the heat developed in the furnace—or, say that the boiler gives to the water 11,600 units of heat for each pound of coal burned, the rest of the heat (20 per cent., or 2,900 units) being lost or used up in the preliminary operations of combustion, maintaining necessary chimney temperatures, radiation, etc.

Such very high furnace and boiler-surface efficiency would result in the evaporation of 12 pounds of water from and at 212 degrees F. per pound of coal consumed. Or, with the water entering the boiler at a temperature of 180 degrees, the steam generated per pound of coal under various pressures would be about as shown in the following short table:—

100 pounds gauge pressure	11.19	pounds evaporation.
125 “ “ “	11.14	“ “
150 “ “ “	11.10	“ “
175 “ “ “	11.00	“ “

Of course, these results are not met with in actual average work, and for the simple reason that the conditions are not, or can not, be easily maintained for their assurance. Expert conditions do not pay for regular duty for the further reason that the coal saved is worth less than the cost of the ultra-efficient service, and that mighty power which we recognize under the name of "the fitness of things" has boiled ordinary service down to what it is, the instincts of the business manager erring more or less in drawing the line, but upon the whole doing very well for a business man.

With the ordinary run of fuel, under ordinary manipulation, probably a development of 11,500 heat units per pound of coal would be fair. And with boilers in the ordinary conditions of cleanliness an absorbing efficiency of 70 per cent. might be considered good; and such a change in the factors of usefulness makes a great change in the results as will be observed in the following:—

Heat units developed per pound of coal	11,500	
Heat units absorbed and transmitted by boiler	8,050	
Evaporation from and at 212 degrees	8.33	pounds.
100 ℔s. gauge pressure, feed at 180°, evaporation	7.76	“
125 “ “ “ “ “ “	7.73	“
150 “ “ “ “ “ “	7.71	“
175 “ “ “ “ “ “	7.67	“

And so it will be seen that the boiler maker, although he can not control the quality of coal and labor destined to be used with a boiler, can at least, by a knowledge of the possible accomplishments under a certain set of conditions, so proportion and construct his boiler as to produce reasonable results. And it is the meeting of the conditions in any certain case, or the failure to meet them, which results in satisfaction or dissatisfaction to the buyer and user. If a manufacturer or a user of steam power is surrounded by a certain set of conditions, it is of no earthly use to him to be furnished with a boiler which shall be highly competent to meet conditions existing a thousand miles away and entirely different from his own. There has been many a quarrel brought about by these very means; sometimes it is sharp practice, and sometimes only a blunder of the boiler maker's, but the buyer in the end generally has to live with the trouble all the same. Professional and disinterested engineering advice may seem expensive to a would-be buyer, before a contract is entered into, but the cost of such advice is a good deal less than loss of time, lack in power, or a law suit; perhaps all three may come on at once.

A steam boiler, then, embraces two separate items; the furnace, comprising the grates and a proper combustion capacity capable of generating the utmost amount of heat from the combustible matter of the fuel; and the steam-tight vessel properly arranged and proportioned for the transmission of the greatest possible percentage of the heat generated to the water within the boiler. And before going further it may be well to state in general terms the lines it is desirable to follow in producing a first-class steam boiler.

A. The choice of the best of materials for the various details of the boiler, and practicable means of ensuring the use of such quality of materials by the boiler maker.

B. The greatest possible simplicity in design and construction, ensuring thereby the ready access to all parts for cleaning and renewals, with the maximum of durability and the minimum of repairs.

C. The most skilful workmanship, including efficient means for manipulating the materials so as to prevent abuse and damage to the stock that may be used, including the drilling of rivet holes instead of punching them, also the planing of the edges of plates, proper form of caulking tools, etc.

D. Steam and water capacity sufficient for the preservation of the water level and the steam pressure within close limits, in conjunction with ample water surface for the disengagement of the steam.

E. The greatest possible circulation of the water with the view of its reaching the different parts of the boiler with sufficient thoroughness to ensure the same temperature of the various parts.

F. When made necessary by the quality of the water, which is with few exceptions, a proper mud-drum for the deposit, at a point removed from the effects of the fire, of all foreign matters likely to form scale upon the heating surfaces. A mud-drum can scarcely be said to be a detriment to any boiler, but there may be situations where it might be omitted.

G. Ample and free passageways from and to the different parts of the boiler, so as to preserve equable conditions of the water and steam pressure and to prevent foaming and priming.

H. Avoidance to the utmost possible extent of the exposure of joints to the direct action of the fire, with special reference to rivets, two or more thicknesses of plates, etc.

I. A large factor of safety as regards strength, over and above the highest possible strains and working pressures; with special care in endeavoring to avoid the deadly enemy of the steam boiler, unequal expansion.

J. Particular attention given to grate areas, combustion chambers, etc., with reference to various kinds of fuel, especially as to hard coal, soft coal, and the different qualities of these separate kinds.

K. The disposal and arrangement of the heating surfaces so as to secure the greatest possible transmission of heat from the products of combustion to the water, always remembering that the heat is the element which does the work, the water acting only as the vehicle for transporting the heat from the combustion to the point of usefulness; also remembering that the greater the percentage of the heat of combustion taken up by the boiler and transferred to the water, the greater the economy.

L. When operating at the full steaming capacity for which it is designed, the utmost fuel economy should be attained by the boiler without undue forcing, or deficiency in the quality of the steam.

In considering the different attributes of the steam boiler, there is no room for argument regarding the importance of the factor of safety. Safety is paramount to all other considerations, and the idea of the necessity of safety is as absolutely instinctive as is the first law of nature, self-preservation.

The wonder is that more explosions do not take place, when all chances are weighed and one stops to think of the enormous aggregate load and capacity for work stored within a boiler. But even as it is, there has been, making an average for the past eleven years, a boiler explosion every two days, involving the death and serious injury of an average of two persons for each day throughout the eleven years.

The reports of the Hartford Steam-Boiler Inspection and Insurance company indicate that out of about a million of boilers met with in their business, more than 11 per cent. were in a dangerous condition. And boilers have exploded very soon after inspection and insurance, or renewal of insurance; and why? For the simple but adequate reason that it is possible to have cracked plates which can not apparently be discovered or known until after an explosion has laid the peril bare. The overlapping seam so commonly used in boiler construction for longitudinal joints is a very treacherous affair at times, and cracks from unequal expansion and other causes may develop unseen in the plates at such seams, gradually growing worse even to the point of destruction, unless a tell-tale leakage of water shall give friendly warning of danger. The butted joint with a welt inside and out is much safer, and really the only proper joint for such a place. Who knows how many lapped seams have a cracked plate gradually approaching the danger line? Of course the actual cause of explosion is, that at some critical moment unforetold and unannounced, when a variety of dangerous factors happen to act together, the strength of the boiler or some part thereof is less than the strain or strains imposed. And as those arch-fiends, unequal expansion and corrosion, begin their work from the moment the boiler is put into service, they will wherever they occur eventually weaken the boiler to a more or less dangerous extent, their special product being fractured plates near or at the seams, and through the lines of rivets.

The desirability of good circulation of water has been already pointed out, and it is no doubt the lack of proper circulation which causes most of the unequal expansion, this varying strain, sometimes enormous, being oftenest caused at the time the boiler is undergoing the process of getting up steam, which would account for the cases wherein boilers have been running along in apparent safety, the pressure has been taken off, the boilers carefully inspected and then fired up again, but explode long before the regular working pressure has been reached, or soon after attaining a pressure no greater than that which they had been under for a long time. Whatever the type of the boiler, one aim should always be kept in view—to provide against straining the material during the cooling off or the heating up so often necessary in practical operation. And in providing against this strain, very much may be accomplished by the manner of arranging the parts of the boiler with relation to one another, so as to take every possible advantage of the elastic qualities of the metal in yielding to distortion of forms to a certain extent, instead of taxing perhaps to the utmost limits the elastic bounds of the material itself by direct strains among its atoms.

This matter of circulation is so important both for economy of heat utilization and for reasons of safety and durability, that it will be well to look a little further into its character. The value and nature of this operation which goes on within a steam boiler may be readily observed, by means of a glass vessel filled with water in which the fluid is caused to boil by applying an alcohol lamp beneath the vessel. The heat from the flame of the lamp striking and spreading under the bottom of the vessel and extending a little way up the sides, especially if the bottom is somewhat rounded, is conducted through the substance of the glass and absorbed by the water in contact therewith. Now, water being a non-conductor of heat to a remarkable degree, in fact almost a perfect non-conductor, although a quick and rapid absorber of heat, but at the same time possessing the quality of expansion when heated, we may observe a very important effect with respect to its action within a boiler. The conduction of heat between the particles of water being so slow as to be practically none at all, but the water in contact with the heated glass absorbing sufficient heat to produce expansion, and reduction of weight per unit of volume, the particles of water thus lightened immediately take to themselves the qualities of flotation with reference to the colder particles, and start upwards for the surface of the body of water. Following the line of least resistance, the heated particles of water keep next to the sides of the vessel, and when they reach the top the action which we recognize as "boiling" of the fluid takes place; the surface being raised and disturbed at the sides, and depressed at or towards the middle of the glass, the latter effect being aided by the downward rush of the cooler water to take the place of that which has been heated and caused to rise. This action starts and maintains the motion of currents in the water which is denominated "circulation," and when this important operation is carried on under a temperature and pressure corresponding to each other steam will be given off at the surface of the water. Circulation of the water in a boiler then, is the act of absorbing heat by the fluid at its places of contact with the heating surface, the rush of the steam and hot water to the liberating surface, and the flow of the cooler water into contact with the heating surface. The facility, ease, promptness, and uniformity with which this action is accomplished in greater or less degrees mark the various qualities of safety, durability, and economy of different designs of steam boilers. Safety, because the uniform heating of the boiler's parts prevents unequal expansion; durability, because the absence of dangerous strains and conditions conduces to longevity; economy, because the complete and rapid heating of the water results in the absorption of the heat generated in the furnace, to the greatest possible percentage.

But the statement of the case as set forth in the heating of the water in the plain glass vessel, as already described, indicates a capacity for heating water which is limited when the line is reached at which the upward-rushing steam interferes with the downward-flowing water.

And the only way so far in the art of boiler making to accomplish anything better and greater than this, is to separate by arbitrary methods the two opposing currents—that is, so to construct the boiler that certain parts are naturally convenient and easy for the escaping steam to go to the liberating surface of the water, and also so that the water which must be turned into steam may easily and naturally go to the heating surface; and as the steam and water under any pressure are at the same temperature, it follows that a rapid and thorough circulation will produce uniform results in heating the various parts of the boiler, it being borne in mind that the most perfect circulation does not take place while steaming because one part of the water is particularly hotter than another part, but because the heated water and steam next the active heating surface is lighter per unit of volume and consequently endeavors to rise to the surface, this effect being assisted by the efforts of the steam to expand in the direction of the outflow, which of course means the steam space of the boiler and thence the steam pipe.

In short terms, when the boiler is such that the upward and downward currents, so to speak, interfere with each other, the boiler will produce over-saturated steam, will foam or prime, and will be wasteful of fuel. But when the boiler is such that the upward and downward currents are separated and arbitrarily kept apart so that each may follow its own course uninterrupted, then more steam may be made, there will be no priming or foaming, and the fuel will be economized.

EDITORIAL COMMENT

In recent years there have been many instances of likeness in the experiences of the two great English-speaking nations, both in home and foreign affairs, and it cannot be doubted that this parallellism has tended to aid the multiplying material ties in drawing British and American sympathies closer together. And now, within a few months of the death of the Queen, the United States have been brought suddenly face-to-face with the situations attending the sudden removal of the head of the political system. After a week of tense anxiety, hope once rising so high that it almost dispelled fear, President McKinley died while his country was yet vibrant with echoes of his last great speech—a speech deeply significant of the broadening of commercial horizons which has come to the United States and to American statesmen since the first inauguration of the late President.

As in the case of the demise of the Crown, the event has been striking in its exhibition of the soundness which has come into the organisation of the modern State since political considerations pure and simple, as they were once understood, (but they were neither "pure" nor "simple") have been deposed from first place and made wholly subordinate to industrial considerations. The rapid and enormous spread of means of communication, whether of persons, goods, or intelligence, has drawn the whole world together to the point where mutual support becomes stronger than mutual rivalry. The upbuilding of sound commercial and financial enterprise, the co-operation in the development and use of natural resources, have created a structure which is itself in the truest sense the State. The State is no longer a mere political ideal, nor only a sentiment of loyalty to a certain dynasty or individual government. It is an embodiment of the material resources of the nation, a centred expression of the forces of production and distribution, to which the executive, administrative, legislative and military are servants and instruments, and to which therefore the passing of even the most exalted and esteemed ruler brings but a passing tremor. The disturbance is somewhat greater in the United States than in Britain because in America economics and party platforms are more closely—too closely—intertwined. But in New York, as in London, an event which not many decades ago might have shaken a continent and upset the peace of nations, does not markedly arrest the course of business nor seriously shake financial security. And this work of industrial development, of trade extension, of spreading and constantly bettering the lines and lanes of communication, is primarily and essentially the work of the engineer.

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At the time of the completion of the tenth year of the publication of The Engineering Magazine, the announcement was made in the April issue of the current year of the forthcoming publicatien of the Third Volume of the Engineering Index. The magnitude of this undertaking has been such as to preclude its completion until the present date, although it has occupied the time of a special and active staff, but we now announce the completion of this great work, and its appearance during the current month.

The extent to which the engineer of to-day is dependent upon current technical literature is hardly appreciated, even by those most conversant with the subject. Any attempt to gather information from text books and works of authority must be accompanied by searches through files of scientific and technical journals if the present state of an art is to be learned, and the amount of labour which such researches involve is not only enormous, but has to be frequently repeated, when it is undertaken independently. With the present volume and its two predecessors, however, the field of technical periodical literature is indexed from 1884 to the close of 1900, in such a manner as to justify us in saying that the work has been done once for all, and he who undertakes a search for any subject of even minor importance on his own account, instead of consulting the Engineering Index, is merely repeating what has already been done for him more fully than he can hope to accomplish by his unaided efforts.

The Third Volume of the Engineering Index is now offered as a fitting memorial of the work of THE ENGINEERING MAGAZINE in its special field, a record of the work of engineers all over the world in the closing five years of the nineteenth century.

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THE present interest in dirigible balloons, largely excited by the experiments of Zeppelin and Santos-Dumont, has revived the question of the possibility of ever achieving any permanent and practical success along such lines. It has long ago been admitted that the success of a balloon which should be dirigible in calm weather or against light winds, was dependent entirely upon the production of a motor which should be sufficiently light and powerful to operate propellers of large enough capacity to move the balloon by which they could be carried. The experiments of Krebs, Renard, and others, as well as numerous model trials, have demonstrated this.

The development of the internal-combustion motor for automobile vehicles has furnished a motor so much lighter than anything possessed by these earlier experimenters, that a measure of success has been attained in the air generally comparable to that secured on land. At the same time it must be remembered that the motor is but one factor in the problem, and that a point must be reached in every case where the force of the wind acting against the body of the balloon must be greater than that of any propeller which it can sustain; and just as there is a limit to the current which can be stemmed by a steamboat, so there must be a limit to the wind against which the most powerfully propelled balloon can be navigated. The dirigible balloon can, at best, be but a special apparatus, possibly useful in some instances in warfare, more probably as an object of interest and amusement at expositions, and very remotely as a means of actual useful travel. The air-ship of the future is far more likely to be a veritable flying machine of the aeroplane type, and in spite of recent developments, it is to the work of Langley and not to that of Santos-Dumont that we must look.

* * *

IN view of the recent discussion at the meeting of the Institution of Naval Architects, concerning the desirability of constructing a testing tank to be at the disposal of private ship-builders for experiments upon hull models, it is interesting to observe that at Washington is the only government tank which is open to the service of the public. The tank at Haslar is available for government work alone, and is fully occupied at that, even if the disposition to place it at the service of private builders existed. Messrs. Denny naturally reserve their private tank solely for their own work, and state that they could keep a second one busy if they had it. The new tank of the North German Lloyds is also private, but the remarkably fine tank at the Washington Navy Yard, while primarily built for the government service, has been available for public service from the first. In addition to this, the remarkably ingenious machinery for the construction of models which shall be accurately reduced copies of the actual hulls, enables all model construction to be omitted by ship-builders, it being only necessary for the drawings to be sent, and the model 20 feet long is made and the autographic records at the desired speeds furnished, at a charge barely sufficient to cover the cost.

In view of the valuable results which have been achieved in the past by the study of the resistance of models, both as to improvement of lines and correct powering of the completed vessel, the importance which was laid upon the testing tank at the meeting of the Institution of Naval Architects is apparent, and it is to be hoped that the efforts of the Institution to establish a public tank will be realised at an early date.

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THE history of the international yacht races covers the entire period of the change from wood to iron, and still later steel or bronze, as the principal material of naval architecture, and it would be strange had there not been a very great accompanying change in the characteristics of the contestants for "The Cup." Probably, however, the most marked changes have occurred during the last twenty or twenty-five years. At the beginning of that period the contest was clearly and uncompromisingly declared between the deep cutter and the shallow centerboard boat, the "skimming dish," as it was contemptuously called, and England and America went to extremes in their devotion to the development of these two types. By a series of mutual approaches, in which it would seem the United States have conceded far the most in principle, the lines of the two models have been brought toward a common type. The bodies of the two yachts are so alike that the layman sees only what seem to him minor differences of modelling; and it is upon these refinements of line and of structure—not on any radical changes—that both British and American designers have been spending their study and labour for some years past. The differences between Shamrock I, Shamrock II, the Columbia, and the Constitution, are so small relatively as to suggest that the designer has nearly reached his limit. It is the metallurgical engineer who has aided him in going so far—possibly in some yet undeclared discovery of the furnace or the rolling mill will lie the possibility of a new line of advance.

* * *

THE strike of the Amalgamated Association in the mills of the United States Steel Corporation, after dragging its slow length along through another month, has reached a settlement which leaves the conditions at some points more unsettled than ever, though the indications point to an early ending of the whole performance. From the labour-leaders' point of view it can hardly appear to have been a highly successful production, and from no point of view does it appear a strongly spectacular one; but probably it has done more to advance the cause of wise and well-ordered unionism than any labour struggle since the great engineers' strike of 1897. Where construction has been so badly designed as that of most of the trade-union "organisers," the first step toward real advance is to pull down what has been done and begin afresh, and Mr. Shaffer has apparently pulled down most of his particular union about his ears. The part which will stand, and by its soundness furnish the plan and pattern by which to rebuild, is that which he could not move when he tried to drag the Amalgamated structure onto the bad ground he had chosen.

* * *

THE lessons of value which have been taught by the strike—which, if accepted and acted upon will form the basal principles of a trades-unionism as helpful to employers as to workmen—are that the labour-organisation, like any other institution, if it is to succeed must be reasonable, just, and responsible. The old adage puts it more tersely—"Honesty is the best policy." And when the unions regard themselves, or are compelled by the courts to hold themselves, responsible for their agreements and their actions, this one new condition will quickly bring to their leadership men of sufficient calibre to direct them with justice and reason. It was largely because of the one feature of irresponsibility that the older unions pushed into prominence the leaders of theatric but reckless type who caused the deplorable and riotous strikes of recent memory. When a vote carried no responsibility, it was lightly cast for the labour demagogue of smooth tongue, fair promises, and light allegiance to ideas of right or order. But when the workingman realises that his ballot involves his material interests in exactly the same sense and proportion as does that of the shareholder in a corporation, he will be more discriminating. The certain result will be the appearance of a class of labour leaders governed by a sense of accountability, akin to that which rules the officers of a business corporation, and with them sound business methods and ideas will begin to dominate the workmen's aims and efforts. For the unions, even more than stock corporations, in kind and in the average are what their officers are. There may be, among the many stockholders of the United States Steel Corporation, men who would have handled its affairs with the weakness, the buncombe, the arbitrary unreason and irresponsibility characterising the attitude and course of the Amalgamated. There may be men in the ranks of the workmen—and the straightforward conduct of some of the lodge shows the type is there—who would have handled matters with the strength, patience, and fairness displayed by the board of the United States Steel Corporation. But the shareholders of the corporation had to assume financial responsibility for the mistakes and all the conduct of their officers; the steel workers ostensibly did not. The one set of conditions brought to the front Mr. Schwab; the other produced the leadership of Shaffer. Recent notes in the press indicate that the British trade unions, alarmed at the decision of the House of Lords referred to in our last issue, are seeking to minimise their tangible responsibility. Their way to success and prosperity, as well as to sound usefulness, lies in frankly and fully accepting it. They cannot force "recognition," but they can win recognition by showing themselves responsible.

So much has been said and written about the "American invasion of Europe" that one introduces the subject with an apologetic air and in an attitude of readiness to dodge should some overtired patience heave a brick at him. The seemingly paradoxical excuse for saying anything more is that there is very apparent danger of saying too much—at least, danger to the American. There is danger to him, first, of being lulled into that very over-confidence of which he accuses Britain, and which gave him his recent great opportunity. There is danger, next, of overlooking in his enthusiasm the apparent fact that he has been to a considerable extent "filling up a hole" in Europe's needs of mechanical and engineering products, and that it looks a good deal as if the hole were getting filled.

By no means would we imply that American exports are going to cease—far the contrary—but merely that the *rate* of the past four years should not be counted on for the future. Britain and the Continent have been "catching up," and the American manufacturer will find his European competitors meeting him with his own ideas, improved where possible.

Export business will be immensely and increasingly valuable to the far-sighted American—an outlet for his full product, a balance against home depression; but it will hardly grow of itself as rapidly as it has done. It will need more cultivation, more active canvassing. He will have to seek it as he does his home business—as the British manufacturer has long sought business abroad.

* * *

THROUGH the negligence—or more probably, it is to be feared—the malicious misconduct of a messenger, the manuscript of the second portion of Herr Lüders' review of "American Machine-Shop Practice from a German View-Point" was lost on its way to the composing room. We yet hope to duplicate it from Herr Lüders' notes; but there is not time before we must go to press to receive his reply from Berlin and get his article into type. The paper must therefore go over until November.

REVIEW OF THE BRITISH PRESS

Recent Marine Engineering.

Among the important papers presented at the recent meeting of the Institution of Mechanical Engineers at Barrow-in-Furness may be mentioned the review of marine engineering, by Mr. James McKechnie. For the three past decades papers have been presented reviewing the progress of the preceding ten years in marine engineering, this making the fourth in a notable series dealing with the greatest engineering industry of Great Britain.

Mr. McKechnie starts out with the proposition that progress must primarily be measured from the standpoint of economy, the success being determined according to the relation between the work accomplished in carrying a given load a determinate distance, and the expense involved in doing it. In determining the progress made, Mr. McKechnie takes his data from actual performances at sea, rightly considering these to be better measures of true progress than results obtained from trial trips.

Considering the advance in fuel economy, it must be remembered that the advance must be a progressively diminishing one. In 1872 the coal consumption was recorded as 2.11 pounds per unit of power per hour; by 1881 it had been brought down to 183 pounds; in 1891, when the triple expansion engine had come into almost universal use, the rate became 1.52 pounds; while a careful analysis of new ships with the latest equipment is about 1.48 pounds.

"The increased economy is partly due to the higher steam pressures now in use. In 1891 the average was about double that of 1881, and now the increase is from 158 lb. to 197 lb. per square inch, the average for forty-five ships with triple-expansion engines built within the past nine months being 180 lb., and for nine steamers with quadruple-expansion engines 214 lb. In former years naval machinery was included in the reckoning, the conditions being similar to those obtaining in the merchant service; but now, with the adoption of water-tube boilers, the practice is dissimilar, and naval ships are not considered in determining this year's averages. As a result of the higher steam pressure and more economical engines, more power is obtained from the boilers per square foot of heating surface, the average per indicated horse-power having in ten years decreased from 3.275 to 3 square feet. At the same time the piston speeds of engines have considerably increased. The average, ten years ago, even including warships, has now become the mean rate for the tramp steamer—530 ft. per minute, while many steamers for high speed attain to 880 ft., a few to 950 ft."

In regard to the question of firing, the closed stokehold system is now rarely used, the forced draught being delivered into the closed ashpit, as in the Howden system, or else there is an induced draught. Concerning mechanical stokers Mr. McKechnie has but little to say, except that there seems a wide field for them, especially if the water-tube boiler, with its large grate, comes into use. He refers to the experiments which have been made on the American great lakes, but really does not give this subject the attention which it really deserves. This is probably natural in a review of the past, but there is hope that before another decade the laborious work of stoking will be mainly performed by machinery.

High steam pressures have come into general use, and indeed there can be little or no gain expected with quadruple expansion with pressures below 220 pounds. This has brought in many difficulties in pipe and joint construction. Solid drawn and lap-welded steel tubing has largely replaced copper; valve boxes and bends being made of gun metal, flange joints being made with metal contacts or asbestos paper.

The development of power has been very marked during the decade under review.

"So far as high-speed machinery is concerned, the universal practice is to fit a four-crank engine operated from four cylinders, usually on the three-stage compound system, and occasionally for quadruple expansion, the cylinders being arranged on the Yarrow-Schlick-Tweedy system. Ten years ago the greatest power developed in any steamer was 20,000 indicated horse-power, and the highest speed on an over-sea voyage 20.7 knots. Now, 30,000 indicated horse-power is the highest in naval practice, the speed being 23 knots, while in merchant practice over 36,000 indicated horse-power has been developed, the mean speed on a transatlantic passage being 23.51 knots, while at the present time there is building a steamer to excel this splendid result. Full credit for this remarkable speed should be given to the company who built the vessel, the Stettiner Maschinenbau Actiengesellschaft "Vulcan," of Stettin, who have built for German owners the two fastest merchant vessels afloat, and are now building two to be at least equal in speed.

"The low-pressure cylinder was only occasionally divided ten years ago, and the greatest diameter was 113 in. In the case of the Campania such a division was made, and although the power was nearly 50 per cent. greater than in the ship with 113 in. low-pressure cylinders, the diameter of the largest cylinders was only 98 in. Experience has shown the enormous importance of balancing forces in the reducing of vibration, so that there has been a further encouragement to divide the third stage or fourth stage cylinders: always provided that tandem cylinders are arranged in couples to balance each other. In this way, even although the power has reached in one set of engines 18,000 indicated horse-power, the largest cylinder is only 106.3 in. against the 113 in. in the 10,000 indicated horse-power engine of ten years ago; the relative steam pressures being 220 lb. and 150 lb. Larger diameters are certainly not desirable, but there is no reason why with higher steam pressure a larger number of expansions should not be adopted with multiple cylinders, because any increase in the number of cranks tends to decrease the vibration. Multiple cranks with reciprocating weights can be so arranged as to minimise the disturbing forces, and the result in the case of the Deutschland is that the vertical vibration measured at the extremities of the 684 ft. ship was only 3/16 in."

In view of the frequent failures of tail-end shafts the rules for their dimensions have been modified to such an extent that according to Lloyd's rule the strength of propeller shafts has been increased 36 per cent. over that required in 1890.

A very important advance has been the greater attention given to the steam consumption of auxiliaries, and tests made on both sides of the Atlantic have showed the large proportion of steam used by the auxiliary machinery. The result has been a marked improvement in the construction of many of the auxiliaries, including the compounding of steam pumps and of engines for driving dynamos. In addition to this, the exhaust steam from the auxiliaries, instead of being delivered directly to the condenser, is passed first to the evaporators or feed water heaters, or delivered to the low pressure cylinder chests of the main engines, doing more work before passing to the condenser, with a resultant economy.

"In the ten years considerable progress has been made in the direction of speed. In 1891 there were only eight vessels whose speed exceeded 20 knots, now there are fifty-eight. The vessels between 19 and 19½ knots speed have doubled, numbering now thirty-four; and Great Britain, it is interesting to note, holds a high position, due in part to the number of high-speed Channel steamers in the Irish Sea, North Sea, and English Channel. The French, Belgian, and Holland high-speed steamers are principally Channel boats, but the five German vessels, and the four of the United States, are ocean liners. The highest speed attained ten years ago was 25 knots, recorded for a British-built Brazilian torpedo boat, the fastest British Navy torpedo boat being 22½ knots; now the record is held by the steam turbine-propelled destroyer Viper, of his Majesty's Navy, which has attained a maximum of 37.113 knots, and a mean for one hour of 36.581 knots. The highest ocean speed ten years ago was 20.7 knots, by the Paris and New York; to-day the highest speed on an ocean run has been achieved by the German liner Deutschland, which has maintained an average of 23.51 knots, while the best speed got with Channel steamers is that attained by the City of Dublin Steam Packet Company's steamers on the cross-Channel run—23.62 knots, with steam of 171 lb. pressure, the power being 8500. These vessels, of 3096 tons builder's measurement, have four-cylinder triple-expansion engines, with four double-ended boilers worked with closed stokeholds.

Mr. McKechnie gives a brief notice to the application of the steam turbine to marine propulsion, and hints that much depends upon the practical performance of the turbine vessel "King Edward."

Summarizing the results of the decade, the following features may be mentioned:

"Steam pressures have been increased in the merchant marine from 15 lb. to 197 lb. per square inch, the maximum attained being 267 lb. per square inch, and 300 lb. in the naval service. The piston speed of mercantile machinery has gone up from 529 ft. to 654 ft. per minute, the maximum in merchant practice being about 900 ft., and in naval practice 960 ft. for large engines, and 1300 ft. in torpedo boat destroyers. Boilers also yield a greater power for a given service, and thus the average power per ton of machinery has gone up from an average of 6 to about 7 indicated horse-power per ton of machinery. The net result in respect of speed is that while ten years ago the highest sustained ocean speed was 20.7 knots, it is now 23.38 knots; the highest speed for large warships was 22 knots and is now 23 knots on a trial of double the duration of those of ten years ago; the maximum speed attained by any craft was 25 knots, as compared with 36.581 knots now; while the number of ships of over 20 knots was eight in 1891, and is fifty-eight now. But probably the result of most importance, because affecting every type of ship from the tramp to the greyhound, is the reduction in the coal consumption. Ten years ago the rate for ocean voyages was 1.75 lb. per horse-power per hour; to-day, in the most modern ships, it is about 1.5 lb. Ten years ago one ton of cargo was carried 100 miles for 10 lb. of fuel, whereas now, with the great increase in the size of ships and other mechanical improvements, the same work is done for about 4 lb. of coal—a result which means a very great saving when applied to the immense fleet of over-sea carriers throughout the world."

Automobiles and Aeronautics.

THERE appears to be little doubt that the present revival of dirigible balloons is in great measure due to the improvements which have been made in light, high-power motors because of the demand for automobile engines. It has long ago been shown that the prinicapl difficulty to be overcome in mechanical flight was the great weight of prime movers in proportion to their power, and it has been the partial solution of the question of light-motor construction which has rendered the modern automobile possible.

An article in a recent issue of the *Automotor Journal* upon the subject of the empire of the air, calls attention to the relation between the two departments of engineering effort, and some points there brought out demand notice and comment.

Modern flying machines are of two main kinds, balloons and aeroplanes, but both kinds have need of power to make them practical. The aeroplane is really a magnified kite, the power being applied to hold the plane surface in position just as the string holds the kite, while the balloon is nothing more than a drifting gas bag unless some propulsive machinery sufficiently effective to maintain steerage-way be added.

Such aeroplanes as have been constructed on an experimental scale, as Maxim's or Langley's, have found the engine problem their main difficulty, always remembering that the still uncertain matter of balancing and steering remains unsolved; while elaborate computations have been repeatedly made to prove that no balloon could ever carry motive enough to make even a few miles headway.

The Santos-Dumont balloon, however, is made with barely sufficient buoyancy to overcome the weight of its machinery, and demands the action of its motor to cause it to rise, and yet it is found that a 16 horse power motor is sufficient to drive it at a speed of upwards of 15 miles an hour, or against an equivalent wind resistance. At the same time it is the motor which has been the cause of most of its designer's difficulties, since it has failed him at certain critical moments, but thus far the questions of weight and motor capacity appear to have been definitely settled as within practicable limits, and the only portion of the motive-power problem remaining is that of reliability and freedom of mishaps

The dirigible balloon should really be regarded as a similar construction to the submarine boat, the latter being made of about the same specific gravity as the medium in which it is operated, and dependent upon its motive power for its vertical as well as its horizontal movement.

It is evident therefore, that all efforts to produce satisfactory motors for automobile purposes are also contributing powerfully towards the solution of the question of aerial navigation, since the two main requirements, power and lightness, exist alike in both instances. The internal combustion motor has been given a high power per unit of weight by reason of the high pressure at which it operates, by the absence of the weight of any boilers, and by the high speed at which it is run. It is along these lines that further improvement must be made if any is to be expected, since they include the three elements of which power is composed, force (pressure) time, and distance (speed). The pressure limit is that of the strength of the materials employed, and this has not yet been carried to its extreme, since the latest and toughest alloys have not yet been used in motor construction. The speed limit has not yet been approached for rotative parts, since the steam turbine has set a pace which no reciprocating motor can approach. Rotary gas engines have been suggested, but as yet no practical information is available about them which would suggest the possibility of so improving them as to make them available. It does seem possible, however, that a gas turbine, running at the speed which some steam turbines have shown practicable, at pressures which are far above any yet used in automobile motors, should render results attainable in aerial navigation which, while not yet secured, are known to depend only upon the question of motive power.

The Construction of Naval Ordnance.

At the Barrow-in-Furness meeting of the Institution of Mechanical Engineers, an important paper was presented by Lieutenant A. Trevor Dawson upon the subject of naval ordnance. Stating the close relation of his subject with the work of the mechanical engineer, Lieutenant Dawson says: "Naval ordnance embraces most of the branches of the science of which the mechanical engineer is the master, and has this further importance: that upon its effective application to our fleet the Empire depends for supremacy, independence, almost for existence. It is true that there are other elements necessary to the fighting efficiency of a warship—speed, invulnerability and radius of action; but these vary according to the duty the ship has to perform, and with our vast Empire marching the territory and touching the susceptibilities of almost every power, such duties are many. Gunpowder, however, must always be a dominant factor, and there is only one class of naval ordnance suitable, and that the best obtainable for the purpose, irrespective almost of financial considerations."

The rate of progress in the armament of warships has been so rapid that some comparative new ships are decidedly inferior in gun power. Thus the "Diadem," launched only five years ago, has 16 6-inch guns, with a total energy of 158,592 foot-tons, while the "Hogue," launched in 1900, will have 12 6-inch guns and 2 9.2-inch guns, with a total energy of 296,516 foot-tons, or nearly double that of the earlier vessel. Since this rate of progress is not confined to British ships, but must be expected in the vessels which the British fleet may some day have to meet, it is most important that the pace should be kept, and that British vessels should not fall behind.

Passing from the military phase of the subject, Lieutenant Dawson proceeds to discuss the mechanical features of gun construction, and gives illustrations of the various types of British and foreign guns of strictly modern design.

Two general systems of construction are adopted by most naval powers—in the one the gun is entirely of steel and in the other of steel and wire. Great stress cannot be laid on the advantages of one system over the other, but it is probable that the highest possible efficiency in construction can be obtained by the proper application of wire, owing to the greater possibility of varying the tension of the wire and the tubes with greater theoretical accuracy that is possible with solid-steel construction.

Details of several of the most modern constructions are shown, taking the British 12-inch 40 calibre gun as an example, this being a wire wound gun with longitudinal stresses taken by the heavy inner tube, jacket, and breech ring. Other types are also shown. The breech block advocated by Lieutenant Dawson is the screw type, with the Welin form of screw, this with the plastic pad obturator enabling a fire of 11 rounds per minute to be attained with the 6-inch gun, and 8 rounds with the 7.5-inch gun, all the shots striking within a metre square of the target at a range of 1,100 yards.

Hydraulic power is to be preferred to steam, compressed air, or electricity for working large guns in barbettes or turrets, and details of approved arrangements are given in the original paper, showing British, American, and German practice. The American plan of superposed turrets is illustrated and described, and while its advantages are fully admitted, the disadvantages, especially as to the possible disabling of four guns at once, are considered to outweigh the merits.

It is impossible in the limits of space here available to examine in detail the mechanical features of the modern guns described in Lieutenant Dawson's papers, but his emphatic views upon the mooted question of submarine boats is especially interesting.

"Submarine boats bear on on the subject of naval ordnance—not so much in association with gunnery, but with torpedo armaments, which constitute a most serious factor in connection with our future naval history. Up to the present time the torpedo has been carried by most of our ships of war, but the maximum serviceability of the weapon must be obtained from such specially designed ships as the torpedo-boat or torpedo-boat destroyer. Now, however, a new field for the torpedo is opened out by the introduction of submarine or semi-submerged boats. Torpedoes are inoperative at a greater range than 2000 yards, and must be discharged within closer distance, so that in the case of two vessels even otherwise unequal, but armed with torpedoes, the chances of success will be equal, and thus it would be impolitic under most circumstances for the superior vessel to take the risk of being torpedoed. For this and other reasons mechanical torpedoes should be utilised by specially constructed vessels, and particularly by boats capable of remaining unseen except for momentary reappearances to take observation. This is a condition easily fulfilled by a submarine boat much more efficiently than by torpedo-boats of the ordinary type. Attack by daylight would make them almost certain victims of any ship armed with a moderately heavy quick-firing gun, escape being impossible; whereas the submarine boat, if discovered when porpoise-like she comes to the surface, can immediately dive, cruise under water for a few miles, and make her escape, to fight another day.

"At the present time the French have thirty-four boats in various states of manufacture, twenty-nine of which are electric submarines and five submersibles, and they are now carrying out important trials and spending large sums of money in their development. Before many years have passed France will have not thirty-four but hundreds, with which she would be able not only to protect her ports, but to make attacks on our fleet in much the same way as the bands of Boers are making guerilla attacks on our regular army in the Transvaal. Of the continuous stream of ships passing up and down the English Channel—the busiest steamship track on the globe—quite 90 per cent. are British vessels, and upon them our mercantile greatness depends. Let us suppose that in time of war 100 French submarines were let loose in the Channel at night. These boats have sufficient speed and radius of action to place themselves in the trade routes before the darkness gives place to day and they would be capable of doing almost incalculable destruction against unsuspecting and defenceless victims. The same applies to the Mediterranean and other ocean highways within the danger zone of the submarine.

The Minerva and Hyacinth Trials.

We have already commented upon the trials of the boilers of the Minerva and Hyacinth in the last issue, and now we have the official report of the runs to Gibraltar and back, with comments by the Controller of the Navy in forwarding the report to the First Lord of the Admiralty.

Since the results have already been fully discussed, and the absence of their value shown to be largely due to the stage of the game at which they were made, there is but little comment to be made upon the report at this time. It is of interest to note, however, that the assumed slowness with which steam can be raised in Scotch boilers was shown never to have had any real foundation, this little incident forcibly reminding us of the anecdote of King Charles II and the goldfish; while the mysterious capacity of the Belleville for receiving water of which no possible account could afterwards be given, either as steam or as leakage, appears to be officially confirmed, but not officially explained.

Just what will be done with the report remains to be seen, and in the meantime the condition of the question of boilers for the navy will continue to remain in the same state of glorious uncertainty which has characterised it for the past year.

A Study of the Electrical Coherer.

In all the experimental and practical work which has been done in space telegraphy it has been realised that it is the coherer which is the fundamental essential of the system, and hence anything which increases our knowledge of this little tube of filings and its behaviour under the influence of electrical waves is of importance and interest. A recent paper by Dr. W. H. Eccles, published in the *Electrician*, gives the results of numerous careful experiments with a great number of coherers, and the discussion of these enables him to deduce a theory of their action which is at least interesting and may prove of practical value.

Dr. Eccles gives a brief historical résumé of the development of the coherer, and although numerous earlier experiments upon the influence of electrical currents upon finely divided metals had been made, he gives fair credit to Professor Branly for having described in 1891, what may be fairly understood as a coherer in the modern sense of the term.

Briefly, as is now generally understood, a coherer consists of a tube of glass containing between two terminals a mass of finely divided metallic particles, usually in the form of filings, these particles having such a high resistance as to prevent the passage of a current in the circuit of which they form a part. Under the influence of the electro-magnetic waves produced by an electric discharge, such as the spark between the terminals of an induction coil, even at a considerable distance, these metallic particles "cohere", or permit, in some way not yet fully understood, the passage of the current. Upon tapping the tube, or otherwise disarranging the particles, the property of conductivity is removed, only to be re-produced by the action of a succeeding wave, and thus signals made by successive electric sparks or discharges, may be transmitted over space and received by an apparatus placed in the circuit of which the coherer forms a part.

Dr. Eccles limits his investigations to coherers made with filings, and by subjecting them to various potentials he endeavoured to discover some logical theory upon which to base their action.

"The phenomenon of coherence, whatever it may consist in—whether it is, as Lodge affirms, a welding together of the two surfaces in pseudo-contact, a reaching of the forces of cohesion across the separating space; or whether it is, as Branly considers, a modification of the dielectric occupying the minute space between the conductors concerned; or, as Bose has proposed, an effect depending on allotropic change in the material of the conducting particles; or, as others believe, one depending on the existence of surface films of condensed gases or moisture—this phenomenon of pure coherence is, in all probability, greatly disguised and complicated in a filings coherer by the preliminary and purely mechanical actions of the particles. That the phenomenon of coherence proper, then, cannot be advantageously studied amid these probable complications need scarcely be pointed out. This view of the case seems also to the writer to account in a great measure for the extraordinary conflict of opinion which has obtained, since Branly's discovery, with regard to various qualities, such as the relative sensitiveness, of coherers made with filings of different metals. To cite only a few cases, it is notable that Marconi, in his patent specification of March, 1897, states that he uses a proportion of silver filings to increase the sensitiveness of his nickel coherers, and that the continued addition of silver greatly increases the sensitiveness;

while Lodge, in the same year, remarked that the noble metals are not suited for coherers. Dorn, in 1898, confirmed Lodge, and with the noble metals placed nickel, adding that only oxidisable metals are sensitive. Branly then announced that, on the contrary, the noble metals are extremely sensitive; and Blondel and Dobkevitch seem to agree with Branly when they state that the less oxidisable metals give lower critical voltages.

"Such confusion has arisen, the writer believes, out of the great complexity of the numerous conditions which influence the mechanical and electrical behaviour of the filings in a coherer. These conditions may be seen to be dependent, broadly, on the state of rest or of motion of the particles and on their relative positions at the moment of coherence; on the nature, probably, of the material of which the filings consist; and on the size and shape of the filings. Evidently the size and shape of the particles each depend on the manner of production—that is, on the kind of file used and the mode of using it, and must also be, for different substances, to some extent dependent on the elasticities, the tenacity, and other properties of those substances. The mechanical circumstances alone are thus extremely involved. But to co-ordinate the experimental data accumulated by the author it was early found necessary to construct a working theory. This theory springs naturally from the results of the first few series of experiments. That these experiments were necessary for the framing of any hypothesis intended to correlate the movements of the particles with the E. M. F.s applied is evident. For, if oscillatory discharges were proved necessary for efficient coherence—that is, in the light of Tommasina's experiment for the formation of numerous chains of cohered particles—then the effect on the movements of the particles of displacement currents in the dielectric must be taken into account; while if, on the contrary, steady E. M. F.s were shown sufficient, then other electro-mechanical connections must be proposed."

After many experiments which gave discordant results, Dr. Eccles finally worked with an apparatus which subjected the coherer under examination to a continuous moderate tapping of about 50 vibrations per second. The coherer was then submitted to known electromotive forces taken from a potentiometer, and the corresponding galvanometer deflections were tabulated and plotted in the form of curves. Details of many of these investigations, together with the results, are given in the original paper, and these all go to confirm the fact that the oscillation of the potential difference is not the cause of the conductivity of the coherer, but that it is due merely to the difference of potential. It is therefore necessary, in practical space telegraphy only to produce the necessary difference in potential.

So far as a theory of the action of the particles in the coherer is concerned, Dr. Eccles inclines toward that of Lodge, with a modification. Assuming that there is a true coherence, he also believes that a mechanical action, depending on the form of the particles takes place, and that this latter is very important. Attempts to sort out the filings by sifting, etc., to obtain such as were truly spherical, as contrasted with those which were elliptical, or irregular, were not successful, and the difficulties in this work are indeed great. At the same time it is altogether probable that the particles tend to place themselves axially with regard to the field, although this cannot be entirely demonstrated.

Electric Power and Industrial Prosperity.

It is generally admitted that national prosperity is closely bound up with the development of technical industry, and this again depends upon the wise use of natural forces, directing them so as to obtain the greatest results with the least expenditure.

The relation of the application of electric power to industrial prosperity is discussed at length in a paper by D. N. Dunlop in recent issues of the *Iron and Coal Trades Review*, and the importance of the introduction of electric driving emphasised. That this introduction has been greatly delayed in the case of British workshops is held to be due to four main reasons:

1. Want of Capital.
2. Excess of caution in investing the capital in electric plants and appliances
3. Disinclination to scrap existing machinery.
4. Lamentable lack of technical knowledge in both employers and employed.

Since Great Britain is now entering upon a century in which she has the active competition of powerful and active nations where she formerly possessed unmolested supremacy, it is most necessary that she should employ the most advantageous methods if she is to hold her own. In the opinion of Mr. Dunlop, victory in the inevitable twentieth-century struggle for commercial and industrial supremacy will surely fall to that nation which is able to make the best use of electric power, and which displays the greatest ingenuity in bringing about by its means economy in labour and increase in output.

The practicability of electric driving is now so fully assured that no demonstration is really necessary, although Mr. Dunlop cites numerous instances of the success with which it has been applied to all kinds of machinery in various parts of the world. Formerly it was thought to be all right for driving small printing presses or other light machinery but out of the question for heavy tools and similar appliances. To-day it is in successful use for operating heavy mine pumps, 100 ton cranes, 70-inch lathes and other heavy machine tools, while every electric tramway is a conspicuous example of heavy electric driving and transmission under most trying conditions.

Leaving then the question of practicability as being fully and admittedly solved, the question of commercial advantage remains; it being assumed that economy in the final cost of the product is the ultimate result to be attained. That electric driving possesses the elements required for commercial economy is summed up in the following advantages: Saving in power, labour, fuel, and repairs; in the cost of buildings, equipment, and clear head room; freedom in the arrangement of machinery and shops, in the growth of premises and distribution of power; a more satisfactory control of speed; great increase in output, in the health bill and cleanliness, and less serious shut-downs for repairs.

The saving in power is mainly due to the economy in transmission, this being the most serious source of loss under the older systems of driving. There is no space here to go into details, but carefully considered figures, collated from many and varied sources, place the saving due to the use of electric power to about 20 per cent. This is in the bare cost of the power itself, and does not include its more efficient application.

The removal of overhead shafting and belting permits the general use of overhead travelling cranes, while the fact that electric power is readily available in all parts of the establishment renders the use of all kinds of handling machinery to replace manual labour. Thus the pay roll is reduced while at the same time the work is more quickly performed and the total output is increased. Herein lies one of the most marked causes of economy. It is generally admitted that the fixed charges of an establishment, interest, depreciation, taxes, motive power, office charges, etc., are about equal to the total pay roll, under the old system, these charges therefore forming about 50 per cent. of the total shop cost of the product. If by the use of electric driving the total output can be increased for the same fixed charges, the percentage of cost on this account is proportionally reduced, and this is one of the advantages of the increased output obtained by the employment of electric driving.

It is admitted that the initial cost of a plant with electric driving is somewhat higher than an equipment of shafting and belting, but this is more than compensated for by the increased advantage with which floor space can be utilised. It has been estimated that the Baldwin Locomotive Works would require 40 per cent. more floor space were it not for the space economy which is secured by electric driving, enabling, as it does, all parts to be equally available for power driven machinery.

The substitution of electric power for nearly all labourious handling reduces the labour cost and at the same time eliminates only the lower class of labour.

"Far from man becoming a mere tool himself when attendance on the machines replaces physical manual labour, the intelligent workman receives a strong stimulus to give his work and the product of the machine his deepest thought, and to endeavour to understand and learn something of the wonders of electricity. There is nothing that reduces a human being more quickly to the level of a machine than constantly repeated physical movement which requires no thought."

REVIEW OF THE CONTINENTAL PRESS

The Commercial Production of Oxygen.

WITH the development of improved processes for the production of oxygen the possibility of extending its uses in the arts naturally appears, and from a paper recently presented by the well-known scientist, M. Raoul Pictet, before the *Société des Ingénieurs Civils de France,* and published in the *Mémoires* of the *Société,* some interesting data on this subject are found.

The old laboratory methods of producing oxygen by heating some of the compounds from which it is most readily separated, are altogether too expensive for extensive employment on a commercial scale, and hence the methods which have been investigated in recent years have had for their end the isolation of the oxygen contained in the atmosphere.

Nearly thirty years ago, the chemist Tessié du Motay invented a method of separating the oxygen of the air by the employment of the oxide of barium. A current of air passed over baryta at a high pressure and moderate increase in temperature produces a binoxide of barium, the oxygen being absorbed from the air. When the pressure is removed the oxygen spontaneously disengages itself and may be collected in a receiver, while the baryta may be used again, thus playing the part of a sponge, which absorbs oxygen at a moderate temperature and high pressure and permits it to escape at a low pressure and higher temperature. Other alkaline metals, such as magnesia, have been used in similar processes, but the cost has in all cases been too high to enable oxygen to be made in commercial quantity.

With the introduction of liquid air, a new method of separating atmospheric oxygen has been made possible. This is based upon the fact that oxygen and nitrogen have different boiling points, and since nitrogen has the lower boiling point it is possible to permit it to boil away from liquid air first, leaving the liquefied oxygen behind. The fact has been carefully verified by experiment that the boiling point of liquid oxygen under atmospheric pressure is —183° C. while that of nitrogen is —195° C. There is therefore a difference of 12° C. in the boiling points of the two gases, and by slowly warming a quantity of liquid air the nitrogen will vaporise first, leaving behind pure liquid oxygen.

Many investigators have sought to find in these facts the source of cheap oxygen, but the high cost of liquid air must bar its direct use for this purpose.

M. Pictet, however, has devised a new and most interesting application of this principle, which bids fair to make cheap oxygen an established fact, and from his paper above referred to we abstract a brief account of his method. He employs liquid air, indeed, but instead of using the extravagant method of making large quantities of liquid air by the Linde process, or some of its modifications, he requires but an original charge of liquid air, and constantly renews this by the action of his process of procuring pure oxygen.

In order to understand how this can be accomplished it will be advisable to examine more closely the process of fractional distillation of liquid air.

In the change of state from the liquid to the gaseous, the nitrogen and oxygen of which the liquid air is mainly composed, absorb heat from their surroundings. If these surroundings can be made to consist almost entirely of atmospheric air, this air jacket will be reduced in temperature, losing as much heat as is required for the vaporisation of the original volume of liquid air. All that would then be necessary is a compressor to reduce the cooled air to the liquid state.

This, then, is the principle of Pictet's new process for the production of liquid oxygen. An initial mass of liquid air is boiled by the heat delivered to it by a current of atmospheric air, this air first passing through a spiral pipe coiled around the reservoir containing the liquid air and then through a second spiral immersed in the liquid. The liquid air slowly evaporates, the pure nitrogen first coming off, followed, as the temperature rises, by mixed nitrogen and oxygen, until finally pure oxygen comes off. In the mean time the air which has passed through the spiral pipes has been lowered in temperature to the critical point, and requires but a feeble pressure to reduce it to the liquid state, and this pressure being supplied by a pump, there is obtained a supply of liquid air equal in volume to that with which the operation was started.

This can be repeated indefinitely, and as the apparatus can readily be arranged so as to render the operation continuous, we have as the only energy expended to produce the distilled gases that required to drive the compressing pump. Thus the quantity of liquid air which is evaporated each instant is replaced by an equal quantity, and no new supply is necessary.

It will be seen how at once this renders cheap oxygen a possibility. M. Pictet gives in his paper the elements of cost, and shows that oxygen 90 per cent. pure can be produced in commercial quantities at a cost of only 0.013 franc per cubic metre, or less than the selling price of common illuminating gas!

M. Pictet calls attention to the fact that in liquefying air there is produced a quantity of solidified carbonic acid, and this is separated from the liquid by filtering. If the air used in his process be mixed with carbonic acid, readily obtained from the waste furnace gases, a large quantity of solidified carbonic acid is produced as a by-product, and as this has a steady market value, its sale is sufficient to defray all the cost of producing the oxygen, which is itself thus made the by-product. In the working apparatus the evaporated gases are collected in three holders, one containing pure nitrogen, the second for the mixed gases, containing about 50 per cent. of oxygen, and the third for the oxygen, about 90 to 95 per cent. pure.

The operation of the apparatus was shown before the *Société* in complete working order, and in his paper M. Pictet gives the detailed thermodynamic computations of the heat interchanges, showing the full accordance of the process with theory.

The possession of cheap oxygen means a complete revolution in many technical processes, and M. Pictet details a few of its applications; while many others will surely be developed.

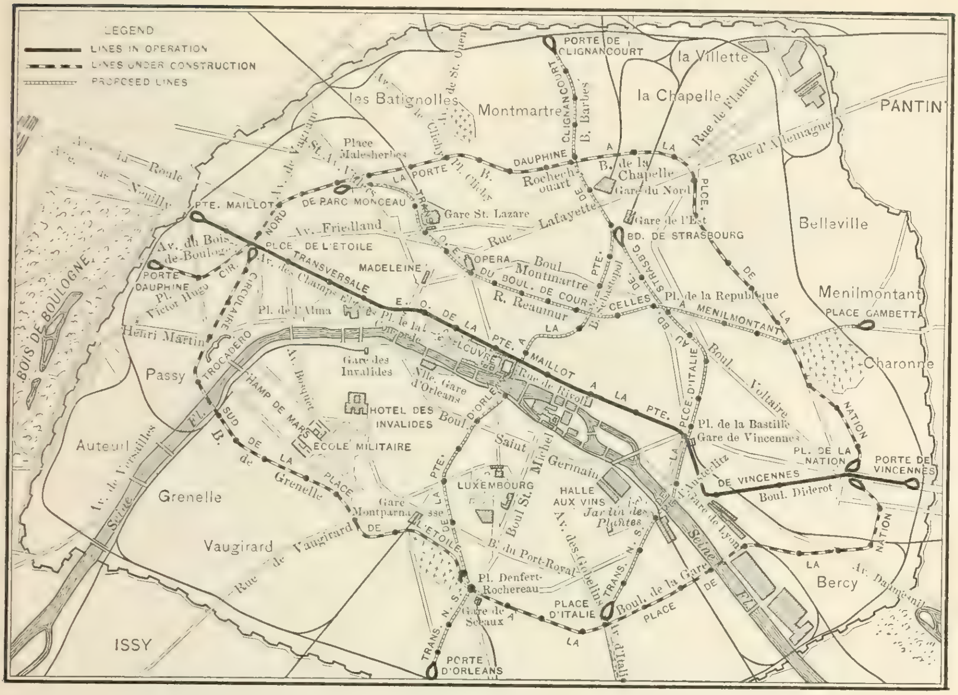
In connection with metallurgy many applications are suggested. Injected into furnaces it will produce the complete combustion of carbon, with intense localisation of heat, if so desired. Used in connection with the vapour of water it gives the most powerful reducing agents known, i. e., carbon monoxide and pure hydrogen, thus enabling the removal of all the injurious metalloids commonly associated with iron, such as phosphorus, sulphur, arsenic, etc.

In connection with forge work the use of oxygen would permit an enormous saving of heat, due to the absence of the diluting nitrogen of the atmosphere, enabling temperatures of 2,200° to 2,400° C. to be quickly attained. The use of the oxy-hydrogen blowpipe becomes a commercial possibility for large work, and welded seams and joints for structural work may in many cases replace riveting.

In chemical technology its applications will be innumerable, and in medicine, any reduction in the price of pure oxygen will be hailed with delight, and instead of being used as a last resort, it will be freely employed for innumerable purposes.

An important application appears in connection with incandescent gas lighting. By burning water gas and pure oxygen the incandescent mantle can be caused to emit a far more brilliant light than is possible with an air-fed burner, while the high temperature thus obtained will render the mantle vastly more durable than with the feebler heat. For more brilliant lighting the oxy-hydrogen light, using cylinders of lime or zircon, becomes commercially possible, while the acetylene flame, fed with pure oxygen becomes far brighter than before, and all deposits which tend to clog the burners disappear.

The well-known reputation of M. Pictet as a careful and conservative scientist, and the high standing of the body before which his demonstrations were made, render this paper one of especial weight and importance, demanding instant attention.



PROPOSED AND COMPLETED PORTIONS OF THE PARIS METROPOLITAIN.

The Paris Metropolitain.

In designing a system of municipal railways, whether for the surface or underground, it is of the utmost importance that a general scheme be made for the entire area to be covered, even though the whole is not intended to be immediately undertaken. In this respect the work in Paris and in New York has decidedly the advantage of that in London. In New York the peculiar shape of the city, forming a long, acute wedge between two rivers, renders a main longitudinal tunnel, such as is now under construction, capable of serving the entire purpose.

In London and in Paris, on the contrary the conditions are altogether different. Each has a portion of the service completed, London having the "tuppenny tube," and Paris having the Porte Maillot—Vincennes section of the Metropolitain in operation. Here, however, the likeness between the two cities ends. London is the battle-field of many independent and rival schemes, involving conflicting interests, methods, and operation. Paris, on the contrary, is proceeding to execute, section by section, a complete underground system, which, when completed will form a consistent whole, in design, construction, and operation.

Without discussing further the situation in London, we may examine the Paris Metropolitain, and show how the present section, in operation for a year, forms part of a whole which will render Paris the best served city in Europe in the matter of local transportation.

The general design of the Metropolitain will be clearly understood from the map taken from *Le Génie Civil.* Broadly speaking it consists of a "circle" following in general the shape of the fortifications on a line about midway between the walls and the island of the *Cité,* together with straight intersecting lines forming diameters running east and west, and north and south. The present line, shown on the map in solid black, is one of the diameters, running under the Avenue des Champs Elysées and the Rue de Rivoli, but this forms only a small portion of the entire work.

The part now under construction, indicated by the heavy broken line, forms the circle or ring line, this portion touching the principal railway stations and such important centres as the Place de la Nation, Place d'Italie, Place Denfert-Rochereau, Trocadéro, Place d' Etoile, and the Párc Monceau. The remaining portions of the system are clearly shown on the map, and include two north and south lines, and an additional east and west line.

It can readily be seen that such a comprehensive scheme is far superior to any combination of independently designed and constructed roads, to say nothing of the advantages resulting from the systematic cooperation of the various sections.

The experience which has been had during the year's operation of the first section has revealed a number of points which are of influence in modifying the actual working of the road. It has been found impracticable to run the trains on a closer headway than two-and-a-half minutes, and indeed the actual timing at present is three minutes, while the traffic upon this section is such that there is no practicability of reducing the number of trains. This being the case, there will be no opportunity of running connecting trains from the new sections, when completed, in between the trains on the present schedule of the Porte Maillot—Vincennes section. The original plan of having the various sections combined to form a number of closed circuits, with trains running continuously in each direction, has necessarily been modified, and each section will now terminate in a loop at each end, as is shown on the map. Each section is therefore to have its own trains, these trains being run back and forth over the various sections, thus avoiding the difficult problem of running trains of various sections upon each other's tracks for any portion of time.

Modern War-Ship Construction.

With the comparatively recent entrance of Germany into ship-building and marine engineering there has naturally developed a special interest in naval construction, and hence the paper of Chief Naval Constructor Hüllman, presented before the recent meeting of the *Verein deutscher Ingenieure* at Kiel, and published in the *Zeitschrift* of the society, demands comment, treating as it does of the general principles of the design of warships in accordance with present German practice.

Like nearly every engineering structure, a warship is a compromise between a number of conflicting conditions. Thus there should be a minimum displacement, and at the same time the maximum of powerful military equipment with its consequent weight. The hull should possess the greatest possible strength and rigidity, with power to stand injuries without being disabled, and yet the vessel itself should form as small a proportion of the total displacement weight as possible, leaving as much as possible for armament and machinery. The speed should be a maximum, consistent with the branch of service for which the vessel is intended, and at the same time the hull must be given a broader beam and fuller lines than are consistent with high speed, in order to provide a sufficiently stable gun platform. A large coal capacity is necessary in order to provide an extended steaming radius, while at the same time it must be realized that every ton of coal carried means a ton less available for armour and equipment. When to these fighting qualities are added the desirability of producing a vessel of good sea-going qualities, having comfortable living quarters for officers and crew, it will be seen that the task of proportioning the relative weight of all these conflicting conditions is by no means a light one.

In earlier times, before the advent of steam propulsion, the problem was a much simpler one, the armament being the principal characteristic, the type being named for the number of guns carried. With the introduction of a steam power and armored protection, however, came the many complications of the modern war ship, and to-day all the ingenuity of the engineer and naval architect is required to produce even a partially satisfactory result.

Reviewing the development of German naval construction during the past thirty years, Herr Hüllman examines the general advances which have been made during that period. In the case of the first heavy armoured cruiser, "Konig Wilhelm," (1868), the weight of the hull formed 44 per cent. of the total displacement, while at the present time the hull weight has been reduced to about 31 per cent., while at the same time the strength, stiffness, and security have been greatly increased.

The question of the increase in the size of warships is somewhat different from that of the merchant marine. In the case of the merchant vessel the advantages of size are obvious, the cost of operation increasing at a far slower rate than the increase in profitable carrying capacity. For the warship, however, there are two sides to be considered. Doubtless the larger vessel has a greater speed per ton of propelling machinery carried, and is capable of bearing heavier armament, so that to-day battle ships are rarely of less than 12,000 tons displacement, while thus far a displacement of 16,000 tons has not been attained. It must be remembered, however, that in naval warfare, large ships mean large tactical units, and that the loss of a single vessel in an engagement means a correspondingly greater injury to the strength of a fleet.

One of the most important questions is that of the proper powering in order that the desired speed may be surely attained. The laws governing the resistance of water are as yet too imperfectly known to enable satisfactory mathematical formulas to be deduced, and it is most desirable that the powering of vessels should be based upon experimental models in testing tanks. Since the first experiments of Froude in England in the early 70's, tanks have been built in various countries, notably by the United States Government at the Navy Yard at Washington, but in Germany there is as yet no government tank, although one has recently been constructed at Bremerhaven by the North German Lloyd Company, for use in connection with the powering of the fast ocean liners under construction for its service.

The demands for increased speeds make corresponding requirements for greater powering, and this has necessarily imposed conditions of weight for machinery which have taxed the ability of marine engineers to the utmost. The principal means which have been adopted for obtaining the maximum power with the minimum weight of machinery, have been higher steam pressures, with the use of lighter, water-tube boilers, and higher piston speeds. In this way it has been found possible to reduce the weight of the engines of battleships of 100 kilogrammes per indicated horse power, by one-third to one-half.

Herr Hüllman goes into the general routine of the design and construction of a warship so far as the limits of a professional paper will permit, and his discussion only emphasizes the fact which is too often overlooked in military circles, that a modern battleship is indeed a fighting machine, and that there is almost nothing left of the work of the old-time shipbuilder or of the duties of the old-time sailor. That such a machine, primarily built for the purpose of mechanical fighting, should be controlled by others than engineers is one of the anomalies of modern warfare, but it may require more than one disastrous conflict for this truth to be driven home to the powers which control military and naval organisation. The nation which first perceives this, and which equips its land and sea forces with modern machinery, operated solely by engineers and machinists, throwing overboard all that pertains to mediaeval militarism, officialism, and bureaucracy, will exhibit such an overpowering supremacy in the time of conflict that the death knell of epaulet-wearing martinets will be sounded everywhere.

Air Brakes for High-Speed Trains.

In considering the question of high-speed trains the problem has generally been considered to be the best method of producing and maintaining the desired speed, but it is almost as important to consider the stopping of the train as the moving of it. The importance of the brake as an element of control has more especially appeared in some of the projects for extremely rapid electric trains, and in a paper recently presented before the *Verein Deutscher Maschinen Ingenieure* by Herr Wagner, and published in *Glaser's Annalen*, the experiments conducted with electrically operated air brakes for the Berlin-Jüterbog military railway are discussed at length.

When the conservative conditions of safety are considered, it is found on the German railways that the continuous pneumatic brakes are not available for trains of more than 60 axles. This practically limits the use of such brakes at high speeds to ordinary passenger trains, and hence for the new military road, which is to be regularly equipped with trains of 110 axles, some modification has been demanded.

The improved brake, tests of which were described by Herr Wagner, is the electric modification by Siemens & Halske, of the well-known Westinghouse air brake, the change being in the substitution of an electro-magnetic device in the place of the triple valve.

Briefly the principle of the Westinghouse brake is the use of the air pressure to maintain a supply of compressed air in auxiliary reservoirs under each car, and at the same time keep this air from acting on the brake cylinders until the pressure in the air main is reduced by the operation of the engineer's valve. The triple valve is arranged so as to be operated by the reduction of pressure in the air main throwing each auxiliary air reservoir into connection with the brake cylinder of its especial car. The duration of the time required for the application of the brakes is therefore that which is necessary for a reduction of pressure in the air mains to act upon all the triple valves throughout the train, and as the contents of the air main is but small the action is very prompt.

The Siemens & Halske modification retains the auxiliary reservoirs of compressed air by each brake-cylinder, but replaces the triple valve by a valve operated by an electro-magnet, the magnets of all the cars on the train being in the same circuit, and the valves being operated instantaneously and simultaneously, whatever the length of the train. The air main is required only to maintain the air pressure in the auxiliary reservoirs, the valves being opened and the brakes set instantaneously throughout the entire length of the train merely by making a single electric contact. This renders the consideration of the length of the train altogether unnecessary, since the time required for the current to traverse the length of the longest train is absolutely inappreciable.

The idea of operating pneumatic brakes by electrical control is by no means new, but the details of the Siemens & Halske apparatus have been well worked out, and the fact that this system has been found acceptable for a road of such interest as the new German military express railway, makes its trials especially important.

The trials were made with the recording apparatus of Kapteyn, by means of which the time is marked automatically in seconds upon a moving strip of paper, while at the same time the distance traveled by the train is recorded from the moment of the application of the brakes until the train is brought to a standstill. The record was also arranged to show the time required for the attainment of full pressure in all the brake cylinders of the various cars of the train, thus enabling reliable comparative records of the pneumatic and electric control to be obtained.

For the full records and tabulated results of the trials the reader must be referred to the original paper, but it appears that in all cases the superior promptness of the electric control was made clearly manifest; in general the train was stopped in about one-half the distance by the electric control than was required with the pneumatic control.

Electric Locomotives on the Orleans Railway.

The extension of the Orleans Railway from its former terminus in Paris at the Place Valhubert by the Pont d'Austerlitz to the new station on the Quai d'Orsay has already been fully described in The Engineering Magazine, and the manner in which the new station in the very heart of Paris is reached by means of a subway running along the left bank of the Seine was fully illustrated in the article by Professor Jacques Boyer in the issue for April, 1899.

Since the use of steam locomotives, filling the subway with smoke and gases, and fouling the atmosphere of the quays above was not countenanced for a moment by such a well-conducted city as Paris, it became necessary to resort to electric traction for the new section of the railway. This electric service has now been in service for nearly a year, and from an article in a recent issue of *La Revue Technique,* we abstract some data and information concerning the working of the electric locomotives on this section.

The locomotives themselves present nothing demanding especial comment, being equipped with General Electric motors and provided with series-parallel controllers of the Thomson-Houston type. The total weight of one of these locomotives is 45 tons, the wheel-base being 6 metres. There are four motors, of 275 horse power each, giving sufficient tractive power to haul a train of 300 tons up a 1 per cent. grade, and such trains are regularly hauled from the old Austerlitz station to the new one on the Quai d'Orsay, a distance of 4 kilometres, in less than seven minutes.

There are eight of these locomotives in the regular service of the subway, handling about 200 trains daily with every satisfaction, the trains being taken by steam locomotives upon their arrival at the Austerlitz station.

When it is remembered that the Orleans Railway is one of the most important in France, operating, with its various branches nearly 7,000 kilometres of track, forming a network over the south and southwest of France, it will be seen that this is a valuable precedent for other great cities which have allowed steam traction, with all its accompanying nuisances of smoke, gas, and heat, to obtain a hold. Any pleas as to the impracticability of introducing electric traction within city limits, in connection with steam traction without, may well be met with a reference to the manner in which the Orleans Railway is handling 200 trains a day of local and through traffic with but eight locomotives, through the heart of Paris.

The Performance of Shearing Tools.

In the July issue we referred in these columns to the study of the performance of shearing tools, as discussed by M. Codron, in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale,* and now we have a continuation of these important researches in a later issue of the same publication.

In that portion of the work already reviewed there was considered the action of a single cutting tool, such as a chisel, acting as a wedge to separate the bar of metal upon which it is forced into two parts. This is a comparatively simple problem, since the forces may be decomposed according to well-known methods of mechanics, the only really indeterminate element being the friction upon the rubbing surfaces of the tool and the metal.

In extending his investigations to double opposing shearing tools, in the article now under consideration, M. Codron enters upon a more complicated phase of the problem. Those who are familiar with the appearance of a freshly sheared section as the bar falls from a double acting power shear, will observe that the actual cutting action of the tools as indicated by the brightly cut surfaces, extends but a short distance into the section on either edge, the remainder of the section evidently having been ruptured by the forcible sliding of the fibres upon each other.

The forces which effect this rupture are of a complex character, partaking more or less of the nature of tearing, bending, and sliding, according to the character of the material.

Considering first cold shearing, M. Codron analyses the manner in which the internal layers of the metal are deformed by compression while the outer layers are actually cut through to a certain depth.

The line passing through the points of greatest deformation is then seen to be a sinuous curve, extending between the two cutting edges, an oblique sliding taking place along this line as soon as the fibres have their ultimate resistance exceeded.

The resistance to shearing is well shown by plotting the pressures and the penetrations in the form of a curve, and this, in the example given of a bar of iron 60 mm. square, shows a continually increasing resistance during the actual shearing, attaining a pressure of 90,000 kilogrammes for a penetration of about 8 millimetres on each side. This pressure was partly occupied in forcing the shearing edges into the metal, and partly in compressing the internal fibres of the bar. From that point the pressure rapidly fell, the inner fibres yielding and sliding upon each other with a continually diminishing resistance, until, with penetrations of about 18mm., the bar fell apart. The mean pressure for the entire cut was about 75 kilogrammes per square millimetre (about 107,000 pounds per square inch).

The relative extent of the cutting and rending action depends largely upon the ductility of the material. Such a substance as rubber, for example, permits such a great degree of compression without rending that the two cutting edges practically meet and shear the compressed section, without tearing it. A similar action takes place in hot shearing, the heating producing a degree of ductility similar to that possessed by the cold rubber.

The contrary action is naturally found to exist with hard steels, the relation of the sheared sections to the torn portion being much greater with a hard tool steel than with a ductile wrought iron.

As a result of a large number of experiments, M. Codron finds that the pressure required for shearing is practically proportional to the section of the bar, the pressure required being equal to a constant, multiplied by the width of the cut and by the thickness of the bar, the constant depending upon the nature of the material to be sheared.

Cut-off and Compression in Steam Engines.

On several occasions attention has been called in these columns to the important researches of Professor Dwelshauvers-Dery, of the University of Liége, upon the action of compression in steam-engine cylinders; and we now have another important communication from him in a recent issue of the *Revue de Mécanique*.

In order to restate his position, a few words of explanation may be appropriate.

It has generally been assumed, following the dictum of Zeuner, that the injurious effect due to clearance in the steam cylinder, could be neutralised in practice by increasing the compression to such an extent that the pressure so produced equalled the initial pressure; the incoming steam not being delivered into an empty clearance space, but finding that space already filled with steam compressed to boiler pressure.

About two years ago, Professor Dwelshauvers announced that his investigations upon the experimental engine in the laboratory of the University of Liége failed to sustain the view of Zeuner, and his experiments certainly appeared to show that with large clearances no practicable degree of compression would compensate for the clearance.

The publication of these results was followed by much comment and discussion, and the general opinion has been one of distrust in the reliability of the experiments, notwithstanding the eminence of the professor, and the completeness of his laboratory equipment. Professor Dwelshauvers himself, on the contrary has had ample faith in the correctness of his experimental results, and has attempted to explain the apparently anomalous results by the effect of cylinder condensation upon the compressed steam. That cylinder condensation plays an important part in the problem is admitted, but since it has openly been maintained by some that the main phenomena discussed by Professor Dwelshauvers were due to leakage in his experimental engine, he has naturally been expected to show that such was not the case.

So far as the question of leakage is concerned, the experimental engine at Liege has been most carefully examined in order to detect any possible influence from this cause upon the experiments. The most conclusive test is the following: When steam is compressed in the clearance space of an engine the pressure rises in a curve, as shown on the indicator diagram. If, at the proper point in the compression, the admission port is opened, giving lead, the live steam entering produces a pressure which joins with the compression to produce a smooth and continuous curve. If the live steam is not admitted soon enough the pressure due to compression ceases to rise, and there is a drop in the compression curve, forming a hook. This hook has been supposed by some to indicate leakage, but Professor Dwelshauvers maintains that the drop of pressure is solely due to condensation, heat being imparted to the cylinder walls more rapidly as the pressure rises. After having made tests with the engine and producing this hook upon the indicator cards, using steam in the engine, it was operated with compressed air, the engine being driven by a motor, and the air drawn in and compressed to the same degree as the steam had been. In this case the compression curve followed the steam compression curve up to a certain point, but then continued on smoothly upward, there being no hook whatever produced. Had the hook in the curve been due to leakage, it would have been produced equally with the steam and the air, but its absence with the non-condensible fluid disposes effectually of the leakage theory.

REVIEW OF THE AMERICAN PRESS

The Treatment of Tool Steel.

THERE have been various statements in the engineering journals about the remarkable properties of an improved tool steel introduced at the works of the Bethlehem Steel Works, by Messrs. Taylor and White, but until now there has been no authoritative publication concerning the nature of the steel and the method of its preparation. For this reason the paper of Mr. Charles Day, recently presented at a meeting of the Franklin Institute, and published in the *Journal* of the Institute, demands especial comment.

Before examining the special composition and treatment of tool steel introduced by Messrs. Taylor and White, it will be advisable to examine the properties of air-hardening steels in general. The principal air-hardening steel heretofore in use is that known as "Mushet" steel. With this steel instructions are given by the makers that the tool must not be heated above cherry red, or it will be burnt, and so ruined. In the course of a series of scientific investigations to remove the question of the behavior of air-hardening steels from an empirical to a scientific basis, it was discovered that while it was true that the so-called breaking-down point of some self-hardening steels was at about a cherry red heat, yet some chemical compositions pass rapidly through this condition to one where a much higher breaking-down point is reached. The breaking-down point, then, varies for steels of various compositions, and it is possible to make an air-hardening steel which shall be heated to above 1,900° F. for the air tempering.

"The composition found to give the best results consists of an air-hardening steel containing at least ½ of 1 per cent. chromium and 1 per cent. or more of another member of the same group, tungsten being found to give the best results. Much better results are obtained, however, by using about 1 per cent. of chromium and about 4 per cent. of tungsten; while for very hard metals, such as the chilled scale on cast iron, etc., 3 per cent. of chromium and 6 or more per cent. of tungsten are especially good. It may be interesting to note that the variation in carbon seems to matter but little, steel varying from 85 to 200 points giving equally good results.

"The method of cooling the tools from the 'high heat' (about 2,000° F.) plays a very important part in the process. Although there are many ways of cooling, each one being adapted to certain classes of tools, they may be described generally as follows: The tool is cooled rapidly from the 'high heat' to a point below the breaking-down temperature in a lead bath, and then slowly in the air, or lime, etc., as the case may be. It is very essential that at no time the temperature should rise, as in such a case the tool would be seriously impaired. After the steel has cooled off, its efficiency is found to be further increased by subjecting it to what is termed the 'low heat' for about ten minutes; this temperature ranging from 700° F. to 1,240 F. After cooling from the 'low heat' the tool is ready for use. In order to obtain the best cutting edge, at least 1-16 inch should be ground off the tool, as the surface is more or less deteriorated by the high heat. The surface of special tools can be protected, however, by some form of flux, thus making it possible to treat milling cutters, etc., by this process. The treatment in all cases extends well back from the point of the tool, and permits of its being ground until so weakened as to require reforging. It is not essential to anneal the steel when reforging, and it might be well to add that all these tools can be worked with comparative ease.

"In the operation of the Taylor-White process apparatus is employed by means of which temperatures can be controlled within very narrow limits, which accounts for the uniformity of results obtained with the tools treated by this process. It has been found necessary to modify the treatment of the special steel used in this process in order to obtain the best results under different conditions, such as varying kinds of metal cut on different types of machines, such as lathes, planers, slotters, drill presses, etc., so that no less than ten different modifications of the treatment are used in the preparation of tools for a large and fully equipped shop working on different kinds of metals and with various classes of tools. The variations required, however, in the treatment are of the most simple and easy application after once being understood, and can be handled with the full degree of success by an ordinary trained laborer.

Mr. Day gives a number of interesting experiences with this steel at the works with which he is connected, the Link-Belt Machinery Company, showing the enormous gain in time and output by the use of a steel capable of such heavy service. Thus the time of boring out a cast-iron ring on a 7-foot boring mill was reduced from fourteen hours to three and one-half hours. The machining of thirteen sheaves with the old tools required nine and one-half hours, while sixteen sheaves were finished with the new steel in five hours and five minutes. Similar results were attained in the machining of steel, the gain reaching and exceeding 60 per cent.

The possession of a tool steel which is capable of being operated at such rates involves a complete change in shop methods to enable the proper results to be attained, and workmen cannot be depended to speed up their tools to the limit practicable without some especial supervision. This is greatly aided by the fact that the steel chips produced by the new steel should be of a blue color when the tool is working dry and at the proper speed. It is therefore only necessary to turn off the water for a moment to see if the tool is working to its highest efficiency.

The necessity for operating machine tools with the new steel at higher speeds than had been originally contemplated by the builders showed the existing speed changes to be inadequate, and hence the introduction of independent electric motors has followed. In this way each tool can be operated at the best speed permissible, regardless of the other tools in the shop, and a flexibility attained which adds still more to the output.

There is every probability that the general introduction of the new steel will extend the policy of scrapping many existing machines simply because they are unequal to the speeds and stresses permitted by the tools to be used in them. The result will be what may be called production to the tool limit, the latest form of intensified production, and one which is altogether desirable because the intensification is that exerted by tools and machines, and involves no additional labor on the part of the men.

Such a system has an undoubted influence upon the labor question, and Mr. Day expresses in a few words the importance of this side of the question.

"The engineer of the present day has before him a tremendous field, the production of the best for the least money, involving a thorough knowledge of every branch of engineering, shop management, etc. The laboring man cannot stop the advance any more than he could in the past, but as he is just as much a part of the whole, as the machine or tool steel, he should be just as carefully watched, his welfare attended to, his physical and mental conditions looked after, and, in fact, be made just as good a workman as possible. In many establishments the machinery is most carefully attended to, while the man who operates it, the keynote of the whole scheme, is ignored. The importance of this fact is now being realized by many concerns, much money being spent, money which will pay big interest, to add to the comforts and welfare of the employees. It should be clearly understood that nothing is offered in the way of a bribe or obligation, the effort being to make the surroundings such that the workmen are both physically and mentally stronger, and in a position to turn out more work unconscious to themselves. Methods like these will, I think, help the labor troubles considerably and facilitate the introduction of new ideas."

The Nernst Lamp in America.

AMONG the papers presented at the Buffalo meeting of the American Institute of Electrical Engineers, one of the most interesting was that of Mr. A. J. Wurts, describing the Nernst lamp as made in America, together with details of the experimental work which has been conducted upon it by himself and his associates at the works of the Westinghouse company at Pittsburg.

Although the Nernst lamp has been the subject of much discussion and interest for more than three years, it has until recently been very difficult to obtain any definite information about the details of its construction, and at the Paris exposition the lamps exhibited were most jealously protected against investigation or inspection. Mr. Wurts's paper, on the contrary, gives illustrations of all the details, and being published in the *Transactions* of the Institute, is readily accessible, while a large number of the lamps are in constant service at the Buffalo exposition.

The original invention of Dr. Nernst, of Göttingen, already noticed in these columns, consisted in using as an incandescent material a pencil of refractory earths, this being a non-conductor when cold, but permitting the passage of the electric current after it becomes heated. The advantage of such an arrangement is that it does away with the necessity of enclosing the incandescent body in an exhausted bulb as is the case with the carbon filament, while also avoiding the necessity of constant renewal, as with arc-light carbons. At the same time the system permits the construction of lamps intermediate in capacity between the arc and incandescent systems, besides yielding a higher electrical efficiency than the latter.

In the original Nernst lamp it was necessary to heat the incandescent pencil by an alcohol lamp or a match until it was made a sufficiently good conductor to permit the passage of the current, after which the resistance kept it sufficiently hot to maintain the conductivity. It was in this crude condition that the Westinghouse company took the invention, and added the improvements which are described by Mr. Wurts.

The first improvement was the method of attaching the connecting wires to the incandescent pencil, or "glower," as it has been named. The glower is about 25 millimetres long and 0.63 millimetres in diameter, and is formed from a dough of rare earths, expressed through a die and cut off in lengths, dried, and roasted. The original lamp had the connections made to this by winding platinum wire around each end. The shrinkage of the glower ends soon made the connection imperfect, but this has been remedied in the American lamp by making the connection to a platinum bead imbedded in each end. By this construction the shrinkage of the glower only tightens the connection. The next improvement made in the American lamps is the introduction of a steadying resistance, or "ballast," to enable the lamp to be operated at the best efficiency. This ballast consists of a resistance of iron wire mounted in a small glass tube filled with some inert gas, this giving a minimum resistance under normal conditions, with a rapidly increasing resistance with increasing temperature. With a 10 per cent. increase of current the resistance of the ballast increases 150 per cent., so that a glower thus protected becomes at once operative throughout a wide range.

In order that the lamp should be commercially satisfactory it was necessary that some automatic method be devised for heating the glower to a point of conductivity. Attempts at electric heaters had been made in Germany, but the problem was attacked from the start in America. It is necessary to heat the glower to a temperature of about 950° C., and hence the heater and its cut-out must be so constructed as to stand high temperatures. The heater consists of a thin porcelain tube overwound with a fine platinum wire pasted with cement, the latter serving as a protection to the platinum wire for the intense heat of the glower. The tubes are wound for 110 volts and are connected in pairs of two in series according to the service, the one, two, and three-glower lamps taking one pair, and the six-glower two pairs. Automatic cut-outs throw the heaters out of circuit as soon as the current is established through the glower, so that the lamp is lighted automatically in about 30 seconds.

Lamps have been made upon the above designs from 50 to 2,000 candle power, and from the exhibits at Buffalo and the experimental tests at Pittsburg, the problem of converting the original Nernst lamp into a commercially available system of illumination appears to have been completely solved.

So far as efficiency goes, it appears that the Nernst lamp lies about midway between the open and the enclosed arc. Comparisons between the Nernst and incandescent lamp indicate a watt consumption in the Nernst lamp of little less than half of that in the incandescent lamp for equal illumination.

The quality of the light is remarkable for its beauty and close approximation to daylight. All colors are seen in their proper shade, making the light especially desirable in stores, art galleries, drawing rooms and the like. The absence of shadow, the simplicity and low cost of maintenance, the high efficiency of the lamp, and the fact that it is operative on 3,000 alternations, are features that will commend themselves strongly to the lighting world.

The Selection of a Steam Boiler.

In the development of a steam plant the boilers, as the originating portion of the power, form a most important division of the whole, and rightly their selection and installation should be given corresponding care. A paper presented before the Engineer's Society of Western Pennsylvania, by Mr. W. E. Snyder, and published in the *Proceedings* of the society discusses this important question at length, and from this communication we make some abstracts.

After emphasizing the necessity for the exercise of proper engineering skill in the inspection of the boiler to be chosen, and condemning the too common practice of leaving the details of its construction entirely to the maker, Mr. Snyder enumerates five points for special investigation, namely:

1. Safety,
2. Convenience of manipulation,
3. Steaming properties,
4. Durability,
5. Cost.

The order in which these are placed is in itself significant. In nearly every case the skilled engineer, who may design boilers, but does not have to live with them, considers first the evaporative efficiency, and tries to design a boiler which will make the most steam with the least fuel. At the same time any man who knows the enormous magnitude of the stored energy in a working steam boiler will fully agree with the propriety of placing safety before everything else.

Mr. Snyder discusses at some length the question of boiler inspection, properly condemning official inspection when it is so mixed up in politics as to permit the appointment of unfit inspectors for political influence; and, while approving of efficient inspection whether official or by insurance companies, he shows the importance of such inspection during the course of manufacture as shall insure the largest margin of original safety. The employment of the best material, with actual testing of portions which go into the boiler, together with the verification of the nominal thickness of sheets, are all urged as matters too often neglected.

In regard to convenience of manipulation, this is properly placed second because continued efficiency depends upon convenience. No matter how good the design of a boiler so far as generating steam is concerned, if it is not capable of being completely and readily cleaned and kept in repair, its efficiency as a steam generator will soon be reduced to that of an inferior boiler. A boiler can best be kept clean inside by putting nothing but pure water into it; and in nearly all cases this costs less than it does to put the impurities in with the water and then take them out in the form of scale. to say nothing of the effect upon the boiler. When possible, a boiler should be so arranged that it can be cleaned, or have tubes renewed without requiring the workmen to go inside of the setting. While it is correct to say that a boiler should become entirely cold before any cleaning or repairing is done, yet at the same time the delay of a few hours in a shut down plant may mean much money, and modern intensified methods demand that quick repairs should be possible when necessary.

Safety and convenience having been provided for as far as practicable, the efficiency in steam generation should be considered.

This brings up at once the mooted question as to the rating of a boiler by the heating surface, and all the disputed points as to the relative efficiency of different kinds of heating surface. When a boiler is completed it is not a difficult matter to ascertain by test what its performance really is, although when the test is not made by a competent person the results may be far from being reliable, especially as regards the use of such a test for a guide in the selection of a similar boiler for another purpose. As a matter of fact the mere question of heating surface is not sufficient to determine the proper rating of a boiler, as one with a low surface rating can be forced to its rated evaporative capacity only by diminishing its economy.

Mr. Snyder discusses the various questions of circulation of gases without and water within a boiler, and also calls attention to the importance of including the quality of steam in the performance of a boiler, and gives a number of practical comments which should assist in selecting a steam generator which should have not only a good test capacity and economy, but should also give good results in continuous daily work.

Durability is a topic upon which little can be said which is not included in the previous qualities. For a well constructed boiler the durability depends more than anything else upon the way in which it is treated. A boiler which is carefully fired, fed with water free from scale or grease, and is not forced far beyond its normal capacity should have a long life. Properly cared for, the working life of a boiler, like nearly every other piece of machinery, should exceed its economical life. That is, it should be found economical to scrap it and replace it with an improved design before it is actually worn out. The depreciation charge against a boiler should therefore be based upon its probable economic life, rather than on its durability, since if it is properly cared for it should certainly last as long as it is advantageous to use it.

The preceding considerations all unite to determine the last item, the cost. A cheap boiler is almost certain to prove expensive in the end, but in paying a good price for a boiler, one should be sure that he is getting what he is paying for.

The time to do the hardest and most efficient work on a boiler plant is in the selection of the boiler, and in the general planning of the details of the plant at that time. If the management of firms making new installations could only be brought to appreciate this thoroughly, it would mean a great saving of money to them, as well as an immense saving of worry and of very hard, unsatisfactory work to their operating forces in coming years.

The Indexing of Engineering Records.

THERE is a general tendency at the present time to consider seriously the importance of avoiding useless repetition of work. People have begun to learn that it does not pay to spend hours of time searching for drawings or hunting for references again and again, when, by a proper system of indexing and arranging, the work may be done in many cases once for all.

In the Engineering Index, it has been sought to arrange and classify all the important articles in the current technical press in such a manner as to render it easy to see what has been published and where to look for it. That some such system is necessary for the proper record of engineering documents in individual offices, is shown by the article by Mr. R. C. Vial upon the indexing of railway maps and drawings, published in a recent issue of *Enginering News.*

"In many railway drafting rooms little attention is paid to an economical system of indexing and filing of records, usually through lack of time for such work. A good index system in connection with an office means a saving of time and energy. Time spent in looking for a drawing or record, due to lack of system, is lost time. A man at $200 a month spending half a day with several assistants looking for some record which, under different circumstances, might be had in a few minutes, does not tend toward low operating expenses, nor the high efficiency of the office."

Mr. Vial describes the system devised for use in the drafting room of the Chicago and Western Indiana R. R., and while in its details it may need modification for other offices, yet in principle it is doubtless sound and convenient.

The general basis of the system is the decimal index, well known in library and similar work, and well applicable to the classification of records. The decimal outline given by Mr. Vial, for which the reader must be referred to the original paper, provides for the main divisions under the even hundreds from 100 to 900, while these are subdivided by tens into their general subclassifications.

At the time of the introduction of the system the drawings were kept in various places, but under the new plan all the plans were transferred to the drafting room, while the reference record is kept entirely upon a classified card index, with guide cards and cross references, in the same manner as is used so extensively for libraries and cost-keeping systems. The convenience and elasticity of the card index renders it especially adaptable to such a changing line of subjects as forms the record material of a drafting office.

Aside from its use in indexing drawings, the card system is used for the tabulation of various data pertaining to the road in the road-master's office. These cards form an index by themselves, and are arranged by station number on each division of the road. Not only is the information thus collected in the most satisfactory form for reference, but the time required in tabulating and arranging in shape is reduced to a minimum. The card index is extended to include an index of the industries along the line, and its uses have developed to such an extent that its capacity has been increased from 4,000 to 10,000 cards.

Mr. Vial describes at length the method of indorsing and filing drawings, but this necessarily differs for various offices and must be modified for each especial case. The main thing is that there should be a system and that it should be so flexible and convenient for record and use as to be always available.

There is plenty of necessary work to be done to render it most important that no time should be wasted in uncertainties, or in looking in many places for what should be immediately available. System and order in records of all sorts have become so essential to success that the only question is that of the most suitable arrangement for the case in hand, and it is by just such descriptive papers as this of which we have spoken that one may benefit by the experience of others.

Long-Distance Transmission Lines.

WITH the introduction of electricity as a means of the transmission of energy from natural sources to points at a distance, many important problems arise which demand care and experience for their solution. For this reason the paper of Mr. F. A. C. Perrine, presented at the Buffalo meeting of the American Institute of Electrical Engineers upon the elements of design particularly pertaining to long-distance transmission, and published in the *Transactions* of the institute, is interesting and important.

Mr. Perrine calls attention to the fact that a large undertaking often differs from a smaller one in more points than merely that of size. Elements which in the smaller problem are of controlling importance do not increase with the increasing magnitude of the whole, while some minor features assume much importance, so that the whole subject has to be worked out anew and handled on its own basis.

"The electrical transmission problem is no exception to this general rule, for, were it always necessary to consider all the phenomena involved in every transmission problem, the solution of a great long-distance problem would be the same as that of the smallest piece of work, since the introduction of larger figures in an equation introduces no difficulties in the solution. But this is not the case. In short distance work there are less terms in the equation than there are in long-distance work, and in handling extremely high potentials we must consider not only the electrical factors of safety, but also mechanical factors of safety, for the reason that good insulations are never materials of great strength and can be relied upon for their mechanical properties only when the mechanical strains are unimportant in comparison with the size of the insulating pieces employed. Were it not for these considerations it might be more expensive to transmit 10,000 k. w. one hundred miles than to transmit the same amount of power a single mile, but to the competent electrician not more difficult. All of the phenomena which must be considered in short distance work are introduced into long-distance problems in the same form. The difficulty in long-distance transmission problems lies in the introduction of phenomena which are not new, but which, as has already been said, are important only in work of the latter class."

Taking up the various questions which arise, Mr. Perrine considers regulation, and shows that it is affected by capacity, mutual induction, and self-induction. With short lines, capacity is the least important of these phenomena, but with long distance lines it becomes the predominant factor. In a line of 100 miles in length, operating at a voltage of 50 to 60,000 volts and a periodicity of 50, the charging current amounts to something in excess of 2,000 kilovolt amperes, and employs such a proportion of the capacity at the station for charging the idle lines as to make the introduction of units smaller than 2,000 k. w. inadvisable, and renders commercially impracticable the transmission of powers less than about 3,000 k. w., unless the capacity effect be neutralized by the use of reactive coils.

Mutual induction can readily be eliminated by transposition, but self-inductive effects, while important, and increased by the length of the lines, are nevertheless comparatively small in reference to the total amount of power transmitted.

"The highest possible potentials are necessary in order to restrict the investment in very long transmission lines. When the voltages rise above 30,000 volts, phenomena become important in the problem of insulation which below that voltage were unnecessary to consider. In the first place voltages from 25,000 to 30,000 volts can be readily handled with insulators of either glass or porcelain having a diameter not exceeding 7 inches. Pieces of glass or porcelain of these dimensions are mechanically strong and are readily manufactured. Where the voltage rises to 50,000 to 60,000 volts, and the sparking distance between the lines increases to between five and six inches, the insulators must have a diameter of at least 12 or 13 inches and be held not less than 7 or 8 inches above the cross arm. Such pieces of these fragile insulating materials are difficult to manufacture, and though the problem has been successfully solved, the greatest care in design and manufacture is absolutely essential, though it is believed that the factor of safety of high-potential insulators as at present designed is by no means as great as that commonly employed with the lower voltages. An even more striking difficulty in handling high voltages lies in the effect of the electrical surface tension, which with high voltages and small wires results in a brush discharge and high energy loss independent of leakage over the surface of the insulators, being simply an escape to surrounding bodies from the whole surface of the wire."

The whole subject of long distance electrical transmission of power forms an engineering problem which from its very bigness, is one requiring the most careful solution at every step, and the fact that it is being now successfully carried out merits the highest praise both toward engineers who undertake the designing and the investors whose faith in their engineers permits the employment of the necessary capital to do the work thoroughly.

Steel Dam Construction.

THE construction of dams is a problem in civil engineering which has received an immense amount of attention, but until recently all the study has been given to timber and masonry dams. The advent of steel and concrete construction, however, has opened up a new system of design, and already this has been employed in situations where the older methods would have been difficult or expensive.

In a recent issue of *Engineering News* is given an account of the new steel and concrete dam at Redridge, Michigan, across the Salmon Trout river, the dam being intended to furnish water to the stamp mills of the neighboring copper mines.

"The Redridge dam is unique in being a gravity dam of combined concrete and steel construction, and in fact it is the first of its kind. Upon the concrete base is a steel superstructure consisting of a series of bents or A-frames carrying steel face-plates, and in this respect the dam is similar to the steel dam built for the Atchison, Topeka & Santa Fe Ry., at Ash Fork, Ariz. The most important difference in the design of the two dams lies in the use of a concrete base in the Redridge dam. In the Ash Fork dam, concrete is used merely to effect a watertight joint at the heel, the steel structure being anchored directly to the rock in a canyon, and relying upon its anchorage to resist overturning or sliding. In the Redridge dam, however, the natural formation was not favorable to such a construction, and it was decided to use a concrete base of such dimensions as to constitute a gravity dam. To this base the steel structure is anchored. The proportions are such that at any section of the dam the resultant of all pressures (when the water is level with the crest of the dam) falls within the middle third of the concrete base. The calculations were made to include sufficient friction to provide against sliding (coefficient of friction, 0.69), but there is a large additional margin of safety against sliding movement through the fact that the concrete base is built in a trench 2 to 4 feet deep in the rock.

"The dam is 1,006 ft. long and the length of the steel portion is 464 ft. between the abutments. The maximum height is 74 ft. At either end of the steel dam are earth embankments with masonry core walls, bringing the total length of the dam to the figure above stated.

Electric Towers.

Under the suggestive title "From Christmas Tree to Pan-American" Mr. Luther Stieringer writes in the *Electrical World and Engineer* of the history of electrically illuminated towers up to the Pan-American exposition. A large portion of the article is purely historical, extending from the first electrical illumination, by Mr. E. H. Johnson, of a Christmas tree for his children in 1882, to the conception and execution of the marvellous lighting effects which have been the delight and admiration of all who have visited the Buffalo exposition.

The earlier towers, shown at various exhibitions from that of the Franklin Institute in 1884 down to the Paris exposition of 1889, were mainly pillars covered with great numbers of incandescent electric lamps, which, by the manipulation of switches and keyboards could be made to exhibit rapidly succeeding changes, many of these being very effective when skilfully handled.

At the Paris exposition of 1889 the Eiffel tower presented a great opportunity which was not altogether utilized at that time, although the graceful outlines of the tower, when marked out in points of light against the dark sky formed a most effective picture. On special occasions, however, the electric effects were mingled with those of fireworks and colored fires, so that this exhibition was only partially electrical. At the Paris exposition of 1900 the tower was much improved in color, and the electrical effect was also much finer and more complete.

The electric tower at the Buffalo exposition is architecturally a more or less faithful copy of the tower of the Giralda at Seville, but in its light treatment it is far finer than anything which has preceded it. Naturally much of the architectural design is lost when it is illuminated at night, and Mr. Stieringer comments with some sarcasm upon the mistaken ideas concerning its appearance before the actual effect was seen. Instead of standing out as a mass of light against the sky, an effect which could only have been produced by throwing the light upon the tower from some outside source, the light is emitted from within in such a manner as to convert it into a special structure, with a beauty entirely its own.

Mr. Stieringer makes some excellent remarks about the proper employment of lighting effects, showing how necessary it is that these should be studied and arranged according to their own principles.

"Lighting is not a matter strictly for architects, but a special art, and the subject of special investigation for those who have to deal in addition with the complex problem of installation. No matter what beauty the architecture may possess, if a funereal aspect is to be presented on occasion, the mourning colors of a country must be chosen to drape the structures, be that white, yellow or black. If the occasion be festive in daylight, bunting in the skilled hands of the decorator will attain a festive transformation. A festive scene at night can only be effected by the aid of illumination and in no way can it be construed as incorporated in the architecture, but it is rather associated with it, and when removed it leaves no evidence of its prior existence. Had it been possible to have treated the illumination of this tower from the inside by translucency to secure a luminous effect, it would have resulted in showing up its grim steel skelton like an ugly radiograph or X-ray picture. A translucent and luminous appearance is produced in an entirely different way from all preconceived notions of the uninitiated. This effect was attained by placing lights so as to secure a nearly uniform illumination over its surface with all desirable points accentuated, producing an effect of brilliancy. The great height and size of this tower and the increased amount of light apportioned to this central section would have made it effective in a popular sense with almost any treatment."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCES IS THE ENGINEERING INDEX"

The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title, (2) The name of its author,
(3) A descriptive abstract, (4) Its length in words,
(5) When published, (6) Where published.
We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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BRIDGES.

Alteration.

Whether to Strengthen the Old Bridge or Renew It? H. G. Tyrrell. Discusses when it is impracticable to make over old bridges; method of estimating, etc. 1000 w. R R Gaz—Aug. 2, 1901. No. 42507.

Arches.

Arch Centers. James W. Rollins, Jr. An illustrated discussion of methods of construction, and design, considering especially the structures described in Mr. Cheever's paper. 1500 w. Jour Assn Engng Socs—July, 1901. No. 42675 C.

Brooklyn Bridge.

Broken Suspension Rods on Brooklyn Bridge. Statement of the accident with report of C. C. Martin, and opinions of Washington A. Roebling. Ill. 2300 w. R R Gaz—Aug. 2, 1901. No. 42510.

The Accident to the Brooklyn Bridge. A letter from Wilhelm Hildenbrand in explanation of the recent accident and of the strength and construction of the bridge. Also short letters from Gus. C. Henning and J. Calvin Locke. 4000 w. Eng News—Aug. 8, 1901. No. 42604.

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The Safety of the Brooklyn Bridge. An editorial discussion of the recent failures of suspension rods, recommending an effective system of inspection. 1000 w. Eng Rec—Aug. 17, 1901. No. 42756.

Cleveland, O.

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Hinged Concrete Bridge at Las Segadas (Pont en Béton de Las Segadas, à Articulations). I. E. Ribera. Illustrated description of concrete arch of 50 meters span, with metal joints at crown and springings, over the Nalon Valley, in the Province of Oviedo, Spain. Two articles, 3500 w. Revue Technique—July 10, Aug. 10, 1901. No. 42812 each D.

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East River Bridge, No. 4. Henry A. La Chicotte. Illustrated description of this fourth bridge to be constructed across the East River at New York, with remarks on the residence district it will make accessible. 1400 w. R R Gaz—Aug. 16, 1901. No. 42678.

The Three Great Suspension Bridges Across the East River, New York. Illustrations and brief notes concerning the bridges completed, in process of construction, and planned. 1200 w. Sci Am—Aug. 3, 1901. No. 42475.

Failure.

Collapse of the Foot-Bridge at the Paris Exhibition. Information from the report of the experts appointed to investigate this accident. 1200 w. Engr, Lond—Aug. 16, 1901. No. 42952 A.

The Fall of a Portable Bridge by Buckling (Chute par Gauchissement d'un Pont Démontable). M. S. Périssé. A discussion of the failure of the bridge over the Adour in 1897, with calculations of the strength and weakness of the girders. 6000 w. 1 plate. Mem Ser Ing Civ de France—June, 1901. No. 42815 G.

North Wales.

Tal-y-Cafn Bridge, North Wales. Description with illustrated details of a bridge built on a site of an ancient ferry. It consists of a steel superstructure supported on limestone masonry abutments, with concrete backing at the shore ends. 800 w. Engng—Aug. 2, 1901. No. 42644 A.

Ornamental.

Ornamental Bridges. H. G. Tyrrell. An illustrated article discussing a few examples of high-class bridge design and construction. 3 two-page plates. 1600 w. Am Arch't—Aug. 24, 1901. No. 42774.

Piers.

Rebuilding Pier No. 4 of the Aqueduct Bridge, Georgetown, D. C. Illustrated description of difficult caisson work in 28 ft. of water, involving the support of the adjoining ends of two spans of a highway bridge on temporary towers while the old pier was torn down and rebuilt. 3100 w. Eng Rec—Aug. 10, 1901. No. 42615.

Reinforced Concrete.

Concrete-Steel Bridges in Porto Rico. Edward Thacher. An illustrated detailed description of two bridges built by the writer, with account of tests of the structures and materials, the difficulties encountered, etc. 5000 w. Eng News—Aug. 1, 1901. No. 42479.

See Civil Engineering, Construction.

Rhine.

New Bridge Over the Rhine.. Drawings and description of the bridge at Worms, with information of the extent and character of the design. 3000 w. Engr, Lond—July 26, 1901. No. 42529 A.

Riveting.

Bridge Riveting in India. J. Graham. Information concerning the work and workmen, wages, etc. Ill. 2200 w. Engr, Lond—Aug. 9, 1901. No. 42734 A.

Stone Arch.

Stone Arch Bridges Recently Constructed on the Fitchburg Railroad. Albert S. Cheever. Illustrated descriptions and accounts of the construction of five bridges recently built on the railroad named. 4 plates. 2200 w. Jour Assn of Engng Socs—July, 1901. No. 42674 C.

Suspension Truss.

The Peissnitz Bridge at Halle-on-the-Saale (Die Peissnitz-Brücke in Halle a. S.). M. Ziegler. Illustrated description of the handsome suspension truss bridge of 70 metres span over the Saale at Halle. 3000 w. Zeitschr d Ver Deutscher Ing—Aug. 17, 1901. No. 42835 D.

Swing Bridge.

Aber Swing Bridge, Carnarvon. Illustrated detailed description of the bridge over the river Seiont. 900 w. Engr, Lond —Aug. 2, 1901. No. 42651 A.

Riveted Lattice Truss Drawbridge; Chicago & Northwestern Ry. Illustrated detailed description of a swing bridge near Milwaukee, with trusses of the type named. 4300 w. Eng News—Aug. 8, 1901. No. 42602.

Viaduct.

Boone Cut-Off and Des Moines River Viaduct; Chicago & Northwestern Ry. Illustrates and describes details of this structure on the new short line. 1800 w. Eng News—Aug. 22, 1901. No. 42906.

The Boone Viaduct. Illustrates and describes some of the details of the steel-work and its erection. 1500 w. Eng Rec —Aug. 24, 1901. No. 42917.

The Erection of the Gokteik Bridge. Day Allen Willey. Illustrated description of this structure in Burma, Asia, which is notable for its height, length, and the remarkably short time in which it was built. 1200 w. Sci Am—Aug. 17, 1901. No. 42668.

The New Riverside Viaduct, New York. Brief illustrated description of the fine viaduct connecting Riverside Drive with the northerly end of Manhattan Island. 800 w. Sci Am—Aug. 3, 1901. No. 42474.

CANALS, RIVERS AND HARBORS.

Cranes.

80-Ton Floating Crane. Two-page plate and engraving of a crane intended for the Santos Harbor Works, with brief description. 400 w. Engng—Aug. 9, 1901. No. 42733 A.

Dam.

The Redridge Dam. An illustrated detailed description of a gravity dam of combined concrete and steel construction, built in the copper region of Michigan, to furnish water to the stamp mills. 3200 w. Eng News—Aug. 15, 1901. No. 42687.

Docks.

Barrow Docks and Approaches by Land and Sea. Frank Stileman. Describes these docks, owned by the Furness Railway Company. Illustrated by 5 plates and 3 figures. 2400 w. Inst Mech Engrs—Aug., 1901. No. 42592 D.

Ore Docks with Metal Piling. Brief illustrated description of one of the ore docks of the Cleveland, Lorain & Wheeling Ry., in which metal pipes are used in its construction; the piles of part of the dock are of wrought-iron pipe, while for the rest of the length they are of steel I-beams. 700 w. Eng News—Aug. 22, 1901. No. 42907.

Feed Gates.

The Electric Feed Gates at Münster and Gleesen (Die Elektrisch Betriebewen Sparschleusen bei Münster und Gleesen). H. Rudolph. A description of the apparatus for regulating the supply of feed water to the upper section of the Dortmund-Ems Canal. Serial, Part I. 3500 w. Zeitschr d Ver Deutscher Ing—July 20, 1901. No. 42822 D.

Lighthouses.

Modern Lighthouses (Les Phares Actuels). G. Leugny. A review of modern illuminating devices for lighthouses, with especial reference to those of France. 2000 w. Revue Technique—July 10, 1901. No. 42813 D.

Mexico.

The Drainage of the Valley of Mexico. Illustrated paper by John B. Body before the Inst. of Civ. Engrs., describing the method of excavating a 29½ mile canal by hand labor, ladder dredges and a cableway. 3600 w. Eng Rec—Aug. 10, 1901. No. 42618.

Mississippi.

The Increasing Elevation of Floods in the Lower Mississippi River. Linus W. Brown. Gives statistics and facts concerning these floods and an outline of the author's views of the cause producing the conditions, and the remedy. Also discussion. 2100 w. Jour Assn Engng Socs —June, 1901. No. 42594 C.

Moldau-Elbe.

The Status of the Canalisation of the Moldau and Elbe at the Close of 1900 (Ueber den Stand der Canalisierungsarbeiten an der Moldau und Elbe am Schlusse des Jahres 1900). J. Riedel. With data of progress and cost, and diagrams of the capacity of locks. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—July 26, 1901. No. 42829 B.

River Sanitation.

The State Sanitary Survey of the Illinois and Desplaines Rivers. A report of the investigations and the conclusions reached by Dr. John H. Long. 3000 w. Eng Rec—Aug. 17, 1901. No. 42757.

Silt-Bearing Streams.

Effects of Dams and Like Obstructions in Silt-Bearing Streams. Elmo G. Harris. A study of the changes due to a deposit of silt, with conclusions reached. 1400 w. Eng News—Aug. 15, 1901. No. 42693.

CONSTRUCTION.

Armory.

The Thirteenth Regiment Armory, Scranton, Pa. Floor plans and details of roof trusses are given with description. 3200 w. Eng Rec—Aug. 24, 1901. No. 42921.

Concrete Floors.

Concrete-Steel Foundry and Power Station Floors. Illustrated detailed description of floors in a machine shop and foundry at Paterson, N. J. 1400 w. Eng Rec—Aug. 17, 1901. No. 42759.

Elevators.

Elevator Construction. John Kennedy. Report of an inspection made of fire-proof grain elevators. 2800 w. Can Engr—Aug., 1901. No. 42568.

Modern Grain Elevators. Illustrated descriptions of two of the latest elevators erected in Minneapolis. 700 w. Sci Am—Aug. 24, 1901. No. 42771.

Excavating.

Steam Excavating and Grading Machine. Illustrated description of a grading machine attached to a traction engine, and its operation. 1100 w. Eng News—Aug. 15, 1901. No. 42684.

Fireproof Construction.

Tests of the Strength of Guastavino Floor Arches. Illustrated report by W. W. Ewing on weight tests of 6, 10, and 12-ft. arches. 1000 w. Eng Rec—Aug. 3, 1901. No. 42541.

Highways.

The Building of American Highways. George Ethelbert Walsh. Discusses the conditions which led to the movement for improved roads, what has been accomplished, the new industry developed, etc. 3800 w. Gunton's Mag—Aug., 1901. No. 42485 C.

Hospitals.

The New Children's Hospitals in Paris (Les Nouveaux Hôpitaux d'Enfants à Paris). M. Seurat. Fully illustrated descriptions of the Hospital Bretonneau and the Hospital Trousseau at Paris, with details of the technical and mechanical equipment. 5000 w. 2 plates. Génie Civil—July 27, Aug. 3, 1901. No. 42802 each D.

Loads.

Diagrams for Calculating the Safe Load on Cast-Iron Columns According to the New York Building Code. A. Samuel Berquist. Gives diagram and explanation of the method of using. It gives also the radius of gyration and sectional area and all information needed in designing cast iron columns. 1400 w. Eng News—Aug. 15, 1901. No. 42686.

Pan-American.

The Horticultural, Forestry and Graphic Arts Buildings of the Pan-American Exposition. Elevation and details, with description of methods of construction. 1800 w. Eng Rec—Aug. 24, 1901. No. 42922.

Piers.

See Civil Engineering, Bridges.

Reinforced Concrete.

Quay Walls and Retaining Walls of Concrete and Iron (Quaimauern und Futtermauern aus Beton und Eisen). A description of the use of the Hennebique system in England and in France. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 9, 1901. No. 42830 B.

See Civil Engineering, Bridges.

Steel Structures.

Effects of Splicing and Riveting. Extracts from a paper by George S. Morison describing experiments on the strength of riveted tension members, with editorial discussing the experiments and Mr. Morison's deductions. 3200 w. Eng Rec—Aug. 10, 1901. No. 42616.

Steel-Work.

The Steel-Work in Skeleton Buildings. Extracts from a lecture by W. C. Furber, discussing rust prevention, fireproofing, and the design of columns. 3300 w. Eng Rec—Aug. 3, 1901. No. 42539.

MATERIALS.

Building Stones.

Building and Monumental Stones of Colorado. Arthur Lakes. Where some of the varieties are found, describing their various qualities and appearance. Ill. 2400 w. Mines & Min—Aug., 1901. No. 42625 C.

Cement.

A Machine for Investigating the Rate and Time of Set of Cement Mortars. Edgar B. Kay. Illustrated description of a machine recently installed in the Cement Laboratory of the College of Civil Engng., Cornell Univ. for investigation uses. 800 w. Eng News—Aug. 8, 1901. No. 42608.

The Decomposition of Cement by Sea-Water. Abstract of a paper by H. Le Chatelier, presented before the International Congress, at Paris, discussing this subject. 2100 w. Eng News—Aug. 15, 1901. No. 42691.

The Omega Portland Cement Works, Jonesville, Mich. Illustrated detailed description of these works and their equipment, and the methods employed. 2700 w. Eng Rec—Aug. 17, 1901. No. 42760.

The Reaction of Sulphate of Lime on Cement (Réaction du Sulfate de Chaux sur les Ciments). M. Deval. A record of analyses and tests, showing the effect of sulphate of lime upon the setting of anhydrous and hydrated cements. 3000 w. Bull Soc d'Encour—July 31, 1901. No. 42821 G.

MUNICIPAL.

Address.

Municipal Engineering. J. M. Smail. An address before the Engng. Sec. of the Royal Soc. of N. S. W. Reviews the development of municipal engineering in Sydney, discusses its general bearing on the interests of the ratepayer, and outlines an ideal municipal government in relation to engineering. 2000 w. Aust Min Stand—July 18, 1901. Serial. 1st part. No. 42728 B.

Drainage.

The Main Drainage of Woking, England. Nicholas Maughan. Abstract of a paper published by the Inst. of Civ. Engrs. Describes the scheme of main drainage of this parish in Surrey, Eng., and the system of sewage purification. 3500 w. Eng Rec—Aug. 24, 1901. No. 42920.

Garbage Disposal.

The Unsatisfactory Condition of Garbage Disposal in the United States. M. N. Baker. Read before the League of Am. Munic., at Jamestown, N. Y. Discusses the inadequate service and primitive methods and suggests points for improvement. 1800 w. Eng News—Aug. 22, 1901. No. 42905.

Garbage Furnaces.

Proposed Garbage Furnaces with Heat Utilization at Buenos Ayres, Argentine Republic. Information concerning specifications for five plants with a combined capacity of 800 tons a day, for which this city calls for bids. 900 w. Eng News—Aug. 8, 1901. No. 42607.

Pavements.

Paving Brick and Brick Pavements. H. J. March. Excerpts from a lecture given before the Engrs.' Soc. of Western New York. 7500 w. Brick—Aug., 1901. No. 42562.

The Expansion of Brick Pavements. Describes the phenomena noticed in several cities where grout filler is used. 1000 w. Eng Rec—Aug. 10, 1901. No. 42619.

Sewage Disposal.

Bacterial Sewage Disposal in England. Extracts from a report by C. H. Rust of the result of investigations in numerous cities. 2000 w. Eng Rec—Aug. 10, 1901. No. 42617.

Preliminary Conclusions of the British Royal Commission on Sewage Disposal. The conclusions given relate to the questions of kinds of land available for sewage treatment, whether the new bacterial processes without subsequent land treatment are sufficient, and what should be done for better river protection. 800 w. Eng News—Aug. 15, 1901. No. 42694.

Sewerage and Sewage Disposal. Solon C. Smith. From a paper read before the Ohio Inst. of Min. Engrs. Discusses the modern methods and the progress of this branch of sanitary engineering. 4000 w. Munic Engng—Aug., 1901. No. 42560 C.

The Biological Purification of Sewage (De Biologische Reiniging van Afvalwater). J. van der Breggen. Description of the septic tank and oxidising beds in use at Winterswijk. 1500 w. De Ingenieur—Aug. 3, 1901. No. 42848 D.

WATER SUPPLY.

Filter.

The Kurka Stone Filter System (Stein filter, System Kurka). With illustrations showing the arrangement of filtering tubes of artificial stone to form large or small units. 1800 w. Glaser's Annalen—Aug. 15, 1901. No. 42833 D.

Reservoirs.

A Concrete Reservoir Lining at Salt Lake City, Utah. Illustrates and describes interesting features of this concrete construction. 900 w. Eng Rec—Aug. 24, 1901. No. 42919.

Open and Covered Service Reservoirs. W. Ingham. Read before the Brit. Assn. of Water-Works Engrs. Extracts from a paper dealing with the design, construction and cost of open and covered reservoirs. 4800 w. Jour Gas Lgt—July 30, 1901. No. 42582 A.

Southern California.

Noteworthy Water Storage and Irrigation Works of Southern California. Robert Fletcher. Describes several important systems and the regions watered. 4800 w. Eng News—Aug. 22, 1901. No. 42911.

Water Problem.

The Question of Water Supply in the South-west. W. C. Potter. The serious trouble about water in Southern California, Arizona, and New Mexico, and the success in overcoming the difficulties is discussed. Ill. 1200 w. Eng & Min Jour—Aug. 24, 1901. No. 42789.

Water Purification.

The Purification of Water by Iron (L'Epuration des Eaux par le Fer). A description of the practical working of the Anderson process with Seine water at Choisy-le-Roi, near Paris. Two articles. 4000 w. Révue Technique—July 10, 25, 1901. No. 42811 each D.

Water-Works.

The Appraisal of the Gloucester Water-Works. Review of a decision by the Massachusetts Supreme Court allowing a private water company, without an exclusive franchise, a large sum for its good will. 2000 w. Eng Rec—Aug. 10, 1901. No. 42613.

Water-Works for the C. R. Baird Co.'s Iron Mines at Ogden, Va. John N. Ambler. Plan and profile of the works is given, with description. The distinctive feature consists in the gravity main of 6-in. vitrified clay pipe which conveys the water from the summit to the mines. 1100 w. Eng News—Aug. 15, 1901. No. 42692.

MISCELLANY.

Irrigation.

Experiments on Winter Irrigation of Deciduous Orchards in Southern Arizona. Summary and conclusions of Alfred J. McClatchie, having a bearing on the design of irrigation works. 900 w. Eng News—Aug. 15, 1901. No. 42689.

National Aid to Irrigation: A Bill to Come Before the Next Congress. Also editorial. Letters from Fred. Bond and George H. Maxwell, discussing the bill. 8000 w. Eng News—Aug. 8, 1901. No. 42605.

Undermining.

The Effect of Railway Tunneling on St. Paul's Cathedral, London. Letter published in the London *Times*, written by Somers Clarke, outlining the condition of this great building. 1900 w. Eng Rec—Aug. 24, 1901. No. 42923.

INDUSTRIAL ECONOMICS

Arbitration.

Industrial Arbitration. Chauncey H. Castle. Read before the Nat. Civil Fed. Con. Gives a plan that has worked most successfully, called a method of conciliation through conference. 3200 w. Am Mach—Aug. 8, 1901. No. 42572.

British Railways.

British Railways as Affected by Higher Fuel, Material and Labor. Compares the records of the five principal railways, to show the general situation, and considers the extent, duration and its incidence. 2400 w. Ir & Coal Trds Rev—Aug. 16, 1901. No. 42949 A.

Cost Keeping.

The Proper Distribution of Establishment Charges. A. Hamilton Church. This third article discusses the scientific machine rate and the supplementary rate, and develops an accurate system. 3300 w. Engineering Magazine—Sept., 1901. No. 42893 B.

Electric Power.

Electric Power as a Factor in Industrial Prosperity. D. N. Dunlop. The present article considers the circumstances which retard the progress of electrical power and the advantages. 3200 w. Ir & Coal Trds Rev—Aug. 16, 1901. Serial. 1st part. No. 42946 A.

German Metal.

German Metal Exports and Imports in 1901. A review of statistics from the report for the first six months of the year. 1000 w. U. S. Cons Repts, No. 1122—Aug. 24, 1901. No. 42781 D.

Labor.

The Classification and Valuation of Labor. David Carnegie. Discusses the need of classification and valuation; how it should be classified; who should value it, etc.; the advantages. 2300 w. Prac Engr—Aug. 2, 1901. No. 42641 A.

Steel Strike.

A Candid View of the Steel Strike. George Gunton. The editor's opinions concerning this strike and his recommendation of a mutual union in which both capital and labor are equally represented, to determine all disputed questions. 3200 w. Gunton's Mag—Aug., 1901. No. 42484 C.

Sugar Industry.

The Development of the Indian Sugar Industry. Discusses the reasons for lack of enterprise, considering the ignorance of the best methods, and the need of better machinery to be in part the cause. 1600 w. Engr, Lond—Aug. 2, 1901. Serial. 1st part. No. 42646 A.

Sweden.

The Swedish Iron, Steel, Metal and Coal Industries in 1900. The report for the year is reviewed. 2000 w. Ir & Coal Trds Rev—Aug. 16, 1901. No. 42954 A.

Tariff.

The New Tariff Duties (Der Neue Zolltarif). The full text of the sections of the new tariff law of Germany relating to iron and steel products. 6000 w. Stahl und Eisen—Aug. 15, 1901. No. 42845 D.

Trade Unions.

The Responsibility of Trade Unions Under the Law. Remarks on the judgment of the House of Lords in the case of the Taff Vale Co. against the Amalgamated Soc. of Ry. Servants et al., adopting the principle that Trade Unions can be sued and held responsible for the acts of their officers. 2000 w. Jour Gas Lgt—July 30, 1901. No. 42576 A.

Upper Rhine.

Notes on the Industries of the Upper

Rhine. John Richards. Interesting account of the wine industry, the commerce of the river, the vessels used, machinery works, and various matters of interest. 8300 w. Jour Assn of Engng Socs—July, 1901. No. 42676 C.

Wages.

What Shall Fix Fair Wages? Editorial discussion of what is a fair wage, with the problems connected, with reference to strikes and the demands at issue. 2000 w. Eng News—Aug. 1, 1901. No. 42481.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

A New Method of Localizing a Fault in a Single Cable. Walter Betts. Describes a method of testing approaching the loop test in accuracy and simplicity. 1000 w. Elec Rev, Lond—Aug. 16, 1901. No. 42937 A.

On a Form of Artificial Submarine Cable. Augustus Trowbridge, in the *Physical Review.* Describes a simple piece of apparatus designed to imitate the action of a submarine cable used in teaching physics. 1300 w. Elec, N. Y. July 31, 1901. No. 42461.

Coherers.

See Electrical Engineering, Electro-Physics.

Exchange.

The New Trunk Exchange No. 1, Berlin. An account of this recently installed exchange, described by Herr Lindow in the *Electrotechnische Zeitschrift,* which is intended to deal with the whole trunk wire traffic of Berlin. 2200 w. Elec Rev, Lond—July 26, 1901. No. 42520 A.

Multiplier.

The Theory of the Multiplier for Rapid Electric Oscillations (Zur Theorie des Multiplikators für Schnelle Elektrische Schwingungen). G. Seibt. A mathematical examination of the multiplier used in space telegraphy by Professor Slaby. 5000 w. Elektrotech Zeitschr—July 18, 1901. No. 42866 B.

Signal Apparatus.

Simple Time Signal Apparatus. S. M. Kintner. Illustrated description of a simple design, installed at low cost to signal the beginning and end of lecture hours at the Western University of Pennsylvania. 1100 w. Am Elect'n—Aug., 1901. No. 42468.

Sounder.

The Morse Sounder. E. C. Barton. An examination of the proper method of proportioning the various parts of a telegraphic circuit. 2000 w. Aust. Min. Stand—July 18, 1901. Serial. 1st part. No. 42730 B.

Space Telegraphy.

Recent Progress in Spark Telegraphy (Die Neuesten Fortschritte auf dem Gebiete der Funkentelegraphie). A. Slaby. An address before the Verein deutscher Ingenieure, reviewing the work of Marconi, Slaby, Tesla, and others. 5000 w. Zeitschr d Ver Deutscher Ing—July 27, 1901. No. 42823 D.

Wireless Telegraph Experiments Between Brussels, Malines and Antwerp. Emile Guarini. An illustrated detailed account of these interesting experiments by the writer. 2300 w. Elec Wld & Engr—Aug. 3, 1901. No. 42542.

Station Signalling.

Methods of Communication in Electric Generating Stations. Considers the methods used in stations, and their value, and advises the addition of a private telephone. 2200 w. Elec Rev, Lond—Aug. 16, 1901. No. 42938 A.

Subways.

Underground Construction. D. R. Craig. The first of a series of illustrated articles dealing with this department of telephone work. 1200 w. Telephony—Aug., 1901. Serial. 1st part. No. 42765.

Telegraphy.

Clark on the Conditions of American Telegraphy. Discusses the map, chart and evidence of Thomas F. Clark, vice-president of the Western Union Telegraph Co., presented before the U. S. Industrial Commission. 1200 w. Elec Wld & Engr—Aug. 24, 1901. No. 42903.

Rapid Telegraphy. Patrick B. Delany. Discusses the causes of delays in sending messages by the Morse system, and maintains that future progress must be in high speed. 1200 w. Elec Wld & Engr—Aug. 24, 1901. No. 42902.

Telephony.

An American Review of Telephony Abroad. A review by U. N. Bethell. An abstract of evidence given before the U. S. Ind. Com., containing much matter of interest. 8700 w. Elec Wld & Engr—Aug. 3, 1901. No. 42543.

A Typical New York Telephone Central Office. Illustrated description of the Eighteenth Street office; a model installation on the common battery system. 1800 w. Elec Rev, N. Y.—Aug. 24, 1901. No. 42786.

Telephone Service in Connection with Long Distance Power Transmission. T. E. Theberath. An illustrated article relating experiences encountered in this work. 1500 w. Jour of Elec—July, 1901. No. 42798 C.

The Rochester Telephone Company's Equipment. Illustrated description of a modern plant for a city of medium size. 1600 w. Elec Rev, N. Y.—Aug. 3, 1901. No. 42555.

The Tunbridge Wells Telephone System. An illustrated account of the undertaking and the opening ceremony. 4500 w. Elec Engr, Lond—Aug. 2, 1901. No. 42642 A.

DISTRIBUTION.

Alternating Currents.

Comparison of Methods of Secondary Distribution of Alternating Currents. George C. Holberton. Read before the Pacific Coast Gas Assn. Principally a comparison of the methods of secondary distribution at 100 volts, 2-wire, 200 volts, 3-wire, and 400 volts, 3-wire. 2700 w. Am Gas Lgt Jour—Aug. 12, 1901. No. 42632.

Calculations.

Some Notes on Electric Light and Power Distribution. Daniel W. Mead. These notes are intended only to give an outline of the subject and point out the basis for calculations and estimates. Considers the electric generator. 1600 w. Munic Engng—Aug., 1901. No. 42557 C.

Frankfort-on-Main.

Electrical Distribution in Frankfort. Illustrated detailed description of this single phase, alternating high-tension system. 1600 w. Engr, Lond—Aug. 16, 1901. No. 42951 A.

Niagara.

Distribution and Conversion of Received Currents. Discussion of paper by Henry Gordon Stott. 5400 w. Trans Am Inst of Elec Engrs—June & July, 1901. No. 42747 D.

Polyphase.

A Large Polyphase Workshop Distribution Plant. Illustrated description of the plant for the New York Navy Yard. 2000 w. Elec Wld & Engr—Aug. 17, 1901. No. 42709.

Switching.

A Discussion of High Tension Switching and Fusing Practices. A discussion upon the papers presented at the convention of the Pacific Coast Elec. Trans. Assn. 7200 w. Jour of Elec—July, 1901. No. 42799 C.

High-Tension Switching and Fusing Devices. R. S. Masson. Read before the Pacific Coast Elec. Trans. Assn. An illustrated article giving some suggestions in high-tension switching. 1800 w. Jour of Elec—June, 1901. No. 42438.

The Latest General Electric Types. H. C. Wirt. Illustrates and describes oil switches and expulsion circuit breakers. 800 w. Jour of Elec—June, 1901. No. 42442.

The Latest Stanley Types. W. Currie. Illustrated descriptions of apparatus. 2000 w. Jour of Elec—June, 1901. No. 42441.

The Latest Westinghouse Types. W. M. McFarland. Illustrates and describes circuit-breakers constructed on the general principle employing the open arc and carbon break. 900 w. Jour of Elec—June, 1901. No. 42440.

The Martin High Potential Switch. F. V. T. Lee. Illustrated description of a switch designed for fulfilling the requirements of the Yuba Power Co. on its 16,500-volt line. 2000 w. Jour of Elec—June, 1901. No. 42439.

Three-Phase.

The Elements of Three-Phase Theory. Alexander Russell. Discusses fundamental theorems, giving mathematical proofs and graphical constructions. 3200 w. Elect'n, Lond—Aug. 16, 1901. No. 42942 A.

ELECTRO-CHEMISTRY.

Address.

Electro-Chemical Industry. J. W. Swan. Abstract of the presidential address delivered before the Soc. of Chem. Ind., at Glasgow, with editorial. 8200 w. Elect'n, Lond—July 26, 1901. No. 42514 A.

Accumulators.

The New Edison Storage Battery. Discussion of paper by Dr. Arthur E. Kennelly. 7500 w. Trans Am Inst of Elec Engrs—June and July, 1901. No. 42750 D.

The Pascal Marino Accumulator. W. Hibbert. Illustrated description of a lead accumulator employing phosphoric acid, with a statement of advantages claimed. 1100 w. Elec Rev, Lond—July 26, 1901. No. 42516 A.

Batteries.

The Battery. S. Lees. Concerning the care of accumulators. Ill. 1800 w. Elec Engr, Lond—Aug. 16, 1901. No. 42936 A.

Fluorine.

Moissan's Researches on Fluorine and the Fluorine Compounds. Dr. H. F. Keller. An account of the researches of this chemist in the field named. Ill. 4500 w. Jour Fr Inst—Aug., 1901. No. 42489 D.

ELECTRO-PHYSICS.

Armatures.

The Conditions of Transformation in the Continuous-Current Armature (Ueber die Transformationeigenschaften der Gleichstromarmatur). F. Eichberg. An examination of the action of the armature, with diagrams enabling the relations of the currents at any point to be determined. 1500 w. Elektrotech Zeitschr—July 11, 1901. No. 42863 B.

The Distribution of Lines of Force in Slotted Armatures (Ueber die Kraftlinienvertheilung in Nuthenankern). E. Dick. A mathematical investigation, taking into account the dimensions of the teeth and the magnitude of air-gaps. 4000 w. Elektrotech Zeitschr—July 25, 1901. No. 42869 B.

Coherers.

Coherers—The Development, Construction, Operation and Function of Electric Wave Detectors. A. Frederick Collins. An illustrated article. 2000 w. Elec Wld & Engr—Aug. 17, 1901. No. 42710.

Magnetism.

The Electromagnetic Effects of Moving Charged Spheres. Edwin P. Adams. A description of experimental investigations, with statement of results. Ill. 3300 w. Am Jour of Science—Aug., 1901. No. 42472 D.

GENERATING STATIONS.

Alternators.

The Construction and Systematic Manufacture of Alternators. O. Lasche. The first of a series of articles which will discuss the conditions underlying the construction and systematic manufacture of alternators of various types. Ill. 1900 w. Engng—Aug. 9, 1901. Serial. 1st part. No. 42731 A.

The Interpolar Induction and Distribution of Copper in the Armature of a Siemens 12-Pole Alternator. Ernest Wilson and William Marden. Describes experiments made at King's College, London, stating the objects in view and the results. Ill. 1100 w. Elect'n, Lond—Aug. 16, 1901. Serial. 1st part. No. 42941 A.

Bangor, Me.

Electrical Supply in Bangor, Maine. Alton D. Adams. Describes the system for supplying light and power. 1100 w. Elec Wld & Engr—Aug. 24, 1901. No. 42901.

Boston, Mass.

The Lincoln Power Station, Boston, Mass. An illustrated description of this new station, which is to supplement the other stations in supplying power for the Boston Elevated Ry. 4000 w. Eng Rec—Aug. 17, 1901. No. 42758.

Brooklyn, N. Y.

The Kings County Station of the Edison Illuminating Company of Brooklyn. Illustrates and describes this station as representing standard practice in high-tension generation. 1600 w. Elec Rev, N. Y.—Aug. 17, 1901. No. 42700.

Buffalo N. Y.

The New Buffalo Terminal Transformer Station of the Cataract Power and Conduit Company. Fred. P. Woodbury. Illustrated detailed description of a station representing the most advanced practice. 1300 w. Am Elect'n—Aug., 1901. No. 42465.

Generating Set.

Two Phase 750 Kilowatt Generating Set by Farcot (Groupe Electrogène à Courants Diphases de 750 Kilowatts de la Maison J. Farcot. An illustrated description of the exhibit of the house of J. Farcot at the Paris Exposition; both engine and generator being built by the one firm. 2500 w. Revue Technique—July 25, 1901. No. 42805 D.

Generators.

The Regulation of Alternating Current Generators. A. S. M'Allister. Considers the causes of change in generator e. m. f., and the advantages of two-phase and three-phase generators. Ill. 2300 w. Am Elect'n—Aug., 1901. No. 42467.

Massena, N. Y.

The Massena Power Development. Illustrated account of the progress of work on this great power plant of the St. Lawrence. 1700 w. Elec Rev, N. Y.—July 27, 1901. No. 42447.

Parallel Running.

Parallel Running of Alternators. A few points on the subject of engine design for this purpose are discussed. 800 w. Elec Rev, Lond—July 26, 1901. No. 42518 A.

The Parallel Operation of Alternators from the Engine-Builder's Point of View. W. Trinks. A discussion of all the elements entering into the successful parallel operation of direct coupled alternators, with brief general discussion. 8800 w. Pro Engs' Soc of W. Penn—May, 1901. No. 42776 D.

Specifications.

Power Plant Specifications. Cloyd Marshall. Discusses the more important elements to be decided in planning an electric transmission system. 2300 w. Engr, U. S. A.—Aug. 15, 1901. No. 42701.

Station Signalling.

See Electrical Engineering, Communication.

Storage Batteries.

Storage Batteries in Central Stations. R. F. Schuchardt. An account of an accident in the Harrison St. station of the Chicago Edison Co., giving load curves showing how the load was dropped by section No. 1, and picked up by section No. 5 and the batteries, and pressure charts showing how quickly the changes were made. 500 w. Elec Wld & Engr—Aug. 17, 1901. No. 42711.

Works.

Hoylake and West Kirby Electricity Works. Illustrates and describes details of the plant and equipment. 1500 w. Elec Engr, Lond—Aug. 16, 1901. No. 42934 A.

LIGHTING.

Arcs.

The Mechanism of the Electric Arc. (Mrs.) Hertha Ayrton. Abstract. The object of the paper is to show that by applying the ordinary laws of resistance all its principal phenomena can be accounted for, without the aid of a large back e. m. f., or of a "negative resistance," or of any other unusual attribute. 2200 w. Elec Rev, Lond—Aug. 16, 1901. No. 42939 A.

Carbons.

The Proper Structure for Carbon Electrodes (Ueber die Günstige Struktur von Kohlenelektroden). J. Härden. With microscopic sections showing the advantages of converting the carbon into the graphite state. 1000 w Elektrotech Zeitschr—July 18, 1901. No. 42867 B.

Illuminated Towers.

From Christmas Tree to Pan-American. Luther Stieringer. An illustrated article giving the history of electrically-illuminated towers. 3600 w. Elec Wld & Engr —Aug. 24, 1901. No. 42900.

Massachusetts.

Electrical Supply Stations in Massachusetts. Alton D. Adams. An account of the electric lighting development in this State. 2800 w. Elec Rev, N. Y.—July 1901. No. 42448.

Nernst Lamp.

Development of the Nernst Lamp in America. Alexander Jay Wurts. Gives the results of the work, and names of those who have been connected with it, reviewing the subject in detail, and pronouncing the lamp a commercial success. Ill. 6200 w. Trans Am Inst of Elec Engrs—June & July, 1901. No. 42755 D.

Private Station.

Public Electric Lighting From a Private Station (Application à l'Eclairage Public de l'Electricité Produite par un Usine pour ses Besoins Personnels). A description of the lighting of the town of Tangermünde, on the Elbe, by current from the plant of the Meyer sugar refinery. 1800 w. Revue Technique—July 25, 1901. No. 42806 D.

Rasch Light.

The Rasch Electric Light. An account of the invention of Herr E. Rasch, of Potsdam, which consists in using the refractory materials used in the filament of the Nernst lamp to replace the carbons of the arc lamp, thus producing a beautiful, steady light equivalent to 75 per cent. of the energy applied. 1500 w. Elec Rev, Lond—July 26, 1901. No. 42519 A.

Ship Lighting.

Lighting Antarctic Ships. Brief illustrated description of the special lighting features of the British steamer "Discovery," which has just started for the South Polar regions. The driving agency is a great windmill on the upper deck. 200 w. Elec Wld & Engr—Aug. 17, 1901. No. 42712.

MEASUREMENT.

Direct Currents.

The Transformer for Measuring Large Direct Currents. Discussion of paper by Harris J. Ryan. 3200 w. Trans Am Inst of Elec Engrs—June and July, 1901. No. 42748 D.

Dynamometer.

Eddy-Current Brakes (Wirbelstrombremse). Dr. K. Feussner. A description of the use of the eddy current brake as an absorption dynamometer for testing small electric motors. 4500 w. Elektrotech Zeitschr—July 25, 1901. No. 42871 B.

Efficiency.

Approximate Methods for the Determination of Efficiency (Leistungsmessung mittels Angenäherter Methoden). G. Stern. A discussion of the errors of certain approximate methods, including the three-wire meter, and various induction meters. 4500 w. Elektrotech Zeitschr—July 18, 1901. No. 42865 B.

Indicators.

Power Factor Indicators. William Hand Browne, Jr. Describes various types of meters and indicators, considering the best method of attaining the end sought. 5300 w. Trans Am Inst of Elec Engrs—June and July, 1901. No. 42753 D.

Synchronism and Frequency Indication. Paul M. Lincoln. Describes these two devices, which were conceived and developed almost simultaneously, giving related information of interest. Ill. 4400 w. Trans Am Inst of Elec Engrs—June and July, 1901. No. 42751 D.

Wattmeter.

Thomson Recording Wattmeter. C. G. Carmichael. Read before the Engng. Soc. of the Sch. of Prac. Science, Toronto. Brief illustrated description, with comparison. 1100 w. Can Elec News—Aug., 1901. No. 42761.

POWER APPLICATIONS.

Electric Clocks.

The Barr, Stout, and Becker Electric Clocks at the Glasgow Exhibition. Illustrated description of these clocks, fourteen of which are installed at the Glasgow exhibition. 1100 w. Engng—July 26, 1901. No. 42525 A.

Electric Driving.

Electricity in the Union Iron Works. W. W. Hanscom. An illustrated description of this plant for power and lighting large works in San Francisco. 4000 w. Jour of Elec—June, 1901. No. 42437.

The Choice of an Electric Power Distribution System in Factories. P. R. Moses. Discusses the merits and demerits of the polyphase alternating system, and the question of best electrical pressure. 3000 w. Engineering Magazine—Sept., 1901. No. 42895 B.

Electric Hoists.

Electric Hoists on the Comstock. Leon M. Hall. Illustrates and describes a continuous rope electric hoist, driven by means of a variable speed, three-phase induction motor. 1200 w. Eng & Min Jour—Aug. 3, 1901. No. 42496.

Electricity in Machine Shops. The first of a series of articles intending to present some of the applications of the electric motor. The present article shows the commercial variable speed motor driving an engine lathe of heavy type. Ill. 1300 w. Ir Trd Rev—Aug. 8, 1901. Serial. 1st part. No. 42596.

Electric Power.

See Industrial Economics.

Elevator.

The Electric Elevator in the Washington Monument. C. M. Lewis. Illustrated description of the light and power plant, elevator machinery, etc. 4800 w. Elec Wld & Engr—Aug. 3, 1901. No. 42544.

The New Electric Elevator at the Washington Monument. Illustrated detailed description of the new elevator, with explanation of the change. 3500 w. Eng News—Aug. 22, 1901. No. 42904.

Induction Motor.

An Asynchronous Induction Motor or Generator with a Power-Factor of Unity. Alexander Heyland. From the *Electrotechnische Zeitschrift*. Describes a method of eliminating the phase difference between current and pressure, and thus at the same time doing away with the wattless magnetizing and light load currents, and the consequences of the air-gap between the stator and rotor. 2000 w. Elect'n, Lond—Aug. 16, 1901. No. 42940 A.

Mining Plant.

Electricity in Mountain Mines. Discussion of a paper by F. W. Brady. 2300 w. Trans Am Inst of Elec Engrs—June and July, 1901. No. 42749 D.

Motors.

Why a motor "Motes." An explanation of why a motor rotates, and why it rotates constantly in one direction under the same conditions. Ill. 4000 w. Power—Aug., 1901. No. 42455.

Pumping.

The Electrically Driven Pumping Plant at the Kaiserstuhl Shaft No. II. at Dortmund (Elektrisch Betriebene Wasserhaltun der Zeche Kaiserstuhl II, bei Dortmund). K. Weitzenmiller. Describing the generators, motors and pumps used in the deepening of a coal shaft, the capacity being 5 cubic metres per minute against 400 metres head. 2000 w. Glückauf—July 20, 1901. No. 42853 B.

Switches.

Some Notes on the Design of Motor-Starting Switches. F. W. Davies. Notes and a few suggestions with reference to starting-switch design. Ill. 1800 w. Elec Engr, Lond—July 26, 1901. No. 42515 A.

TRANSMISSION.

Bay Counties.

The World's Longest Electric Power Transmission. George P. Low. An illustrated popular description of the system of the Bay Counties' Power Co., in California, introductory to technical descriptions to follow. 10200 w. Jour of Elec—July, 1901. No. 42797 C.

Lighting.

Protection Against High Pressures (Schutzvorrichtungen gegen Schädliche Ueberspannungen). G. Benischke. A paper on lightning arresters and protection against high tension currents, with discussion. Presented before the Elektrotechnische Verein. 5000 w. Elektrotech Zeitschr—July 11, 1901. No. 42864 B.

The Relief of Conductors Charged With Statical Electricity (Die Ladung von Freileitungen mit Statischer Elektricität und deren Ableitung). H. Müller. A discussion of the principles involved in the construction of devices for relieving highly charged line wires. 2000 w. Elektrotech Zeitschr—July 25, 1901. No. 42870 B.

Line Performance.

Performance of an Artificial Forty-Mile Transmission Line. William S. Aldrich and George W. Redfield. An account of a test carried out in the Elec. Engng. Laboratory of the Univ. of Illinois, the results representing closely what might be expected under commercial conditions of a similar line. 4200 w. Trans Am Inst of Elec Engrs—June and July, 1901. No. 42752 D.

Long Distance.

Elements of Design Particularly Pertaining to Long Distance Transmission. F. A. C. Perrine. Discusses points arising in carrying out a long-distance transmission. 2800 w. Trans Am Inst of Elec Engrs—June and July, 1901. No. 42754 D.

Practical Power Transmission. John Martin. Read before the Pacific Coast Gas Assn. States the conditions in California and the satisfactory service now possible within reasonable distances. Also discussion. 7200 w. Am Gas Lgt Jour—Aug. 26, 1901. No. 42784.

MISCELLANY.

Electric Furnace.

A New Electric Furnace. Concerning a furnace recently patented in England by Mr. A. Parker which appears to have solved many of the difficulties under which carbide has been made. 1400 w. Elec Rev, Lond—July 26, 1901. No. 42517 A.

Radiography.

Radio-Active Substances and Their Radiations. George B. Pegram, in *Science*. A review of the recent work in this field. 4800 w. Elec Rev, N. Y.—July 27, 1901. No. 42449.

GAS WORKS ENGINEERING

Acetylene.

Lighting by Acetylene. Frederick Dye. The present article gives an elementary outline of how acetylene is made and used. 2300 w. Plumb & Dec—Aug. 1, 1901. Serial. 1st part. No. 42638 A.

Railway Lighting by Acetylene Gas. John S. Seymour. Explains a system of lighting by this gas, discussing its advantages. 2300 w. Ry & Engng Rev—Aug. 24, 1901. No. 42796.

Address.

Inaugural Address Before the North British Association of Gas Managers. W. R. Herring. Discusses modern methods and questions of interest to the gas industry. 4700 w. Jour Gas Lgt—July 30, 1901. No. 42577 A.

Benzols.

Composition, Examination, and Application of Benzols. Dr. F. Frank, in *Chemische Industrie*. Abstract from the *Journal of the Society of Chemical Industry*. Explains methods of testing commercial benzols. 1500 w. Jour Gas Lgt—Aug. 6, 1901. No. 42721 A.

Carbonization.

Influence of the Physical Condition of Coal on the Quality of the Products of Carbonization. M. Verdier. Read at the meeting of Société Technique. Gives investigations, results, and conclusions. 1200 w. Jour Gas Lgt—Aug. 6, 1901. No. 42720 A.

Coals.

Coals: Their Composition, Properties and Uses. W. Ivison Macadam. Lecture before the Irish Assn. of Gas Mgrs. Considers the formation, composition, calorific power, weight of gases and photometric tests. 3500 w. Gas Wld—Aug. 17, 1901. No. 42944 A.

Diluting Gases.

The Economical Production of Diluting Gases. C. B. Tully. Read before the Irish Assn. of Gas Mgrs. An account of interesting work at Sligo, with discussion. Ill. 2800 w. Gas Wld—Aug. 7, 1901. No. 42943 A.

Distribution.

Modern Methods of Distributing Gas. Norton H. Humphreys. An explanation of the methods and motive power for distributing systems. 3400 w. Jour Gas Lgt—Aug. 13, 1901. No. 42745 A.

Domestic Fuel.

Promotion of Domestic Fuel Gas Consumption. R. P. Valentine. Read before the Pacific Coast Gas Assn. Suggestions for increasing the demand for gas as a fuel. 1800 w. Am Gas Lgt Jour—Aug. 12, 1901. No. 42633.

Enrichment.

Gas Enrichment. A. Yuill. Read before the N. Brit. Assn. of Gas Mgrs. Deals especially with enrichment by benzol. 2000 w. Jour Gas Lgt—July 30, 1901. No. 42578 A.

Gas Enrichment. Discussion of paper by A. Yuill. 5000 w. Jour Gas Lgt—Aug. 6, 1901. No. 42718 A.

Gasholder.

A Giant Gasholder and Its Erection. Illustrated detailed description of the erection of a large gasholder for the East River Gas Company of New York. 2000 w. Ir Age—Aug. 22, 1901. No. 42742.

Gas Strike.

History of the Cork Gas Strike. A summary of the official history prepared by the directors, giving a glimpse into the conditions under which the works were carried on. 2300 w. Gas Wld—Aug. 10, 1901. No. 42725 A.

Improvements.

Modernizing the Carbonizing Plant at the Chester Gas-Works. An illustrated description of interesting alterations. 2000 w. Jour Gas Lgt—July 30, 1901. No. 42580 A.

International Congress.

Report on the International Congress of the Gas Industry (Paris, France, September, 1900), to the Pacific Coast Gas Association. J. B. Grimwood. 5400 w. Am Gas Lgt Jour—Aug. 12, 1901. No. 42631.

Lecture.

Light. Prof. Ivison Macadam. Lecture delivered before the N. Brit. Assn. of Gas Mgrs. Gives information on the analysis of light, testing, different burners, and the Welsbach, or incandescent burner, with general conclusions. 3200 w. Jour Gas Lgt—July 30, 1901. No. 42579 A.

Natural Gas.

A Furnace System Using Natural Gas. Illustrated description of a heating system in residence at Wheeling, W. Virginia. 1800 w. Met Work—Aug. 10, 1901. No. 42595.

Purifier-Boxes.

Expanded Metal for the Construction of Purifier-Boxes. P. Bachelay. Read at meeting of the Société Technique. A note on the use of this material and its advantages. Ill. 800 w. Jour Gas Lgt—July 30, 1901. No. 42581 A.

Retort-Charging.

A Retort-Charging Machine. A. Cabrier. Presented at meeting of the Société Technique. Illustrates and describes the machine, explaining its principle and method of working. 900 w. Jour Gas Lgt—Aug. 13, 1901. No. 42746 A.

Scrubber.

A New Type of Scrubber. R. W. B. Creeke. Read at meeting of the N. Brit. Assn. Traces briefly the changes which have taken place in scrubbers, defining the difference between a scrubber and a washer, and giving an illustrated description of a new machine scrubber. Discussion. 3800 w. Jour Gas Lgt—Aug. 6, 1901. No. 42719 A.

Subways.

Concrete Subways for Underground Pipes. Extracts from a paper by Arthur Taylor Allen read before the Society of Engineers. Illustrates and describes a suggested construction, with its lighting, ventilation, etc. 3200 w. Gas Wld—Aug. 10, 1901. No. 42726 A.

Tunnels.

Subaqueous Tunnels for Gas Conduits. W. W. Cummings with discussion. Illustrated description of methods of construction used in three river crossings recently carried out by the Massachusetts Pipe Line Gas Co. 8 plates. 7500 w. Jour Assn Engng Socs—June, 1901. No. 42-593 C.

Water Gas.

Water Gas Installation on the Strache System. Details of the more important plants erected on a working scale and the results obtained. Ill. 4600 w. Jour Gas Lgt—Aug. 20, 1901. Serial. 1st part. No. 42973 A.

MARINE AND NAVAL ENGINEERING

Battleships.

Modernizing Battleships. S. Eardley-Wilmot. Discusses the reconstruction of these vessels, alluding to the practice of France, and Austria, and the course that should be taken by England. 2000 w. Naut Gaz—Aug. 22, 1901. No. 42783.

The Construction of War Ships (Ueber den Bau von Kriegschiffen). H. Hüllman. A discussion of the general problems of design, equipment, armament, etc., based on the development of the German Navy. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 17, 1901. No. 42834 D.

The New Battleship Design Controversy. Gives a sheer plan and deck plan of each design, with a diagram showing the maximum concentration of fire possible from the intermediate and secondary batteries of each vessel, with discussion of the arguments. 2200 w. Sci Am—Aug. 10, 1901. No. 42587.

Boilers.

See Mechanical Engineering, Steam Engineering.

Chain-Steamer.

Chain-Steamer of the Royal Bavarian Line Upon the Upper Main River, Germany. Abstracted from an article by Eduard Weiss, in *Zeitschrift des Vereines Deutscher Ingenieure.* Illustrated detailed description of sprocket-wheel type of ship, with turbine propellers, its equipment and operation. 2200 w. Eng News—Aug. 1, 1901. No. 42480.

Clipper Ship.

Details of Construction of the Famous American Clipper Ship Great Republic. Reprint of a description of this vessel written at the time of her construction, about fifty years ago. Ill. 2900 w. Marine Engng—Aug., 1901. Serial. 1st part. No. 42492 C.

Dry Docks.

The Floating Dry-Dock at Havana. An illustrated general description of this steel dock bought of the Spanish government for $185,000, and intended for use in the Philippine Islands. 3200 w. Marine Rev—Aug. 8, 1901. No. 42634.

Explosives.

High Explosive Shells. Editorial concerning some experiments made by Sir Hiram Maxim, with discussion of other explosives. 2700 w. Engng—Aug. 2, 1901. No. 42645 A.

Ferryboat.

Fine New Ferryboat. Illustration, with description, of the Lakewood, a double-screw ferryboat for N. Y. harbor, belonging to the Cent. R. R. of N. Jersey. 900 w. Naut Gaz—Aug. 22, 1901. No. 42782.

The Northfield Accident. Brief illustrated account of the damage to this ferryboat while leaving New York on June 14, by the "Mauch Chunk" colliding. 500 w. Marine Engng—Aug., 1901. No. 42490 C.

Folding Boat.

The "James" Folding Boat. Illustrated description of a boat which received the approval of the British Board of Trade under the Life Saving Appliances Act. 1000 w. Ind & East Engr—July, 1901. No. 42717 B.

Framing.

The Computation of Statistically Indeterminate Systems in Shipbuilding (Berechnung Statischer Unbestimmter Systeme in Schiffbau). Franz Kretschmar. A mathematical study of the statics of framed structures applied to the design of ship framings. Serial. Part I. 2000 w. Schiffbau—July 23, 1901. No. 42859 D.

Ironclads.

Modernizing Ironclads. S. Eardley-Wilmot. Discusses what is to be done with out-of-date ships of this class. 1800 w. Engr, Lond—Aug. 2, 1901. No. 42647 A.

Launching.

Novel Means of Launching a Vessel. Illustrates and describes the method used in restoring light-ship No. 50 to the water, after being high and dry upon the beach. 1200 w. Marine Rev—Aug. 1, 1901. No. 42501.

Lengthening.

Lengthening of the S. S. "Iroquois." An illustrated description of work of cutting and lengthening a steamship, carried out at the Erie Basin, New York. 1000 w. Sci Am—Aug. 31, 1901. No. 42970.

Load Line.

Determination of the Line of Flotation of a Ship for Variable Loading (Bestimmung der Schurinm linie eines Schiffes bei Trimänderungen). J. Meyer. A mathematical investigation in rectangular coordinates, with diagrams for various forms of hulls. 2000 w. Schiffbau—Aug. 8, 1901. No. 42861 D.

Marine Railroad.

The Largest Marine Railroad in the World. Ralph C. Davison. An illustrated description of the cradle, the ways and the hauling-out gear, etc., with statement of the advantages. 1200 w. R R Gaz—Aug. 9, 1901. No. 42610.

Naval Engineers.

The Position of Naval Engineers. Report of the arguments submitted to the First Lord of the Admiralty in England, by a deputation representing the N. E. Coast Inst. of Engrs. & Shipbuilders, the Inst. of Marine Engrs., London, and Inst. of Marine Engrs. (South Wales). 8000 w. Engr, Lond—July 26, 1901. No. 42533 A.

Navigation.

On Sea Charts Formerly Used in the Marshall Islands, with Notices on the Navigation of These Islanders in General. Capt. Winkler. 4500 w. Ill. Sci Am Sup —Aug. 31, 1901. No. 42972.

Ocean Ships.

A Brief History of Ocean Passenger Ships. Lawrence Irwell. An interesting review of this service from its beginning. 6000 w. Marine Rev—Aug. 1, 1901. Serial. 1st part. No. 42502.

The White Star Liner "Celtic." Illustrations and interesting information concerning this vessel, the largest yet built. 1400 w. Sci Am—Aug. 17, 1901. No. 42667.

Review.

Review of Marine Engineering During the last Ten Years. James McKechnie. An interesting review of the development, with 11 plates and other illustrations, 15 tables and much information. 10600 w. Inst of Mech Engrs—Aug, 1901. No. 42588 D.

Screw Propulsion.

Pioneer Screw Vessels of the Lakes. Illustrations and notes from Samuel R. Kirby, concerning early vessels. 800 w. Marine Rev—Aug. 8, 1901. No. 42635.

The Evolution of the Screw Steamer. Benjamin Taylor. Gives Col. John Stevens the credit of being the first to apply steam as a motive power to screw propellers, and discusses the origin and development. Ill. 2800 w. Marine Rev—Aug. 15, 1901. No. 42704.

Shamrock II.

The Eleventh Challenger for the America Cup—Shamrock II. Illustrated article discussing features of this fine yacht, with editorial. 2200 w. Sci Am—Aug. 24, 1901. No. 42773.

Shipbuilding.

A Century of Steam Ship Building. From the *Monthly Review* (England).

The present year is the hundredth anniversary of the use of steam as a motive power for ships, and a review of the development is given. 4200 w. Marine Rev—Aug. 22, 1901. No. 42775.

Naval and Merchant Ship Construction in the United States During the Past Year. Abstracted from the introduction to the "Blue Book of American Shipping." 1500 w. Eng News—Aug. 15, 1901. No. 42695.

The Arrangement and Equipment of Shipbuilding Works. James Dunn. Discusses the general principles dominating the plan of shipbuilding works, tools and their arrangement, closed-in versus open berths and the cranes serving them, etc. Tables and 12 plates. 7700 w. Inst Mech Engrs—Aug., 1901. No. 42591 D.

Ship Design.

Form Calculations from Lines of Ships. Theodore Lucas. The first of a series of articles dealing with the lines of ships. 1500 w. Naut Gaz—Aug. 8, 1901. Serial. 1st part. No. 42583.

Shipyards.

Shooters Island Shipyard. Illustrated description of the works covering this island, at the mouth of Newark Bay. 1100 w. Marine Engng—Aug., 1901. No. 42493 C.

The Steel Ship Yards of the United States. Waldon Fawcett. Illustrated article giving information concerning the shipyards of the South. 1400 w. Am Mfr—Aug. 8, 1901. No. 42636.

Steamships.

The Steamship M. S. Dollar. Illustrated description of this recently launched vessel of the three deck type. Also describes the engines. 1200 w. Marine Engng—Aug., 1901. No. 42491 C.

Submarine.

Submarine Boats (Onderzeeche Booten). H. H. Versteegh. A general historical review, together with some account of recent submarines. Two articles. 5000 w. De Ingenieur—July 20, 27, 1901. No. 42846 each D.

Tender.

Fine New Light-House Tender. An illustrated description of the "Larkspur" now building. 1600 w. Naut Gaz—Aug. 15, 1901. No. 42705.

Testing Tank.

The Ship-Model Testing Tank in Use at the Denny Ship-yard in England. Extract from an article in the *N. Y. Herald*, by J. D. Jerrold-Kelley, giving an account of the new system of testing ships' models in this private testing tank. 2000 w. Naut Gaz—Aug. 8, 1901. No. 42584.

Torpedo Boats.

The Standardization and Contract Trials of the U. S. Torpedo Boats Bagley and Barney. Brief description with data of trials. 900 w. Marine Engng—Aug., 1901. No. 42494 C.

Transport.

The United States Transport "Sumner." An illustrated description of the work of conversion, and the completed ship. 2500 w. Engng—Aug. 16, 1901. No. 42957 A.

Yukon Route.

The Talbiksak River; A Possible Shortening of the navigable route of 320 miles, thus avoiding the most dreaded part of the Bering Sea, and making it possible to enter the region two weeks earlier. 1600 w. Eng News—Aug. 22, 1901. No. 42913.

MECHANICAL ENGINEERING

AUTOMOBILES.

Automobile Test.

Regulations for the First Long Distance International Automobile Test in America. Rules and regulations for the 500-mile, New York-Buffalo endurance test to occur in Sept. 3000 w. Elec Wld & Engr—Aug. 3, 1901. No. 42545.

Automobiling.

Automobiling in the West. Charles B. Shanks. An illustrated account of experiences encountered during the attempt made by Alexander Winton to cross the North American continent in an automobile. 3800 w. Sci Am Sup—Aug. 3, 1901. No. 42478.

Balancing.

Balancing Double Cylinder Motors. From *La France Automobile.* Explains a system devised by Panhard & Levassor to absolutely balance the rotary parts of a motor. Ill. 600 w. Horseless Age—Aug. 28, 1901. No. 42962.

Bicycles.

Motor Bicycle Design. Douglas Leechman. Deals with the adaptation of the safety bicycle to motor driving, considering the position of the motor, steering, side-slip, etc. Ill. 3500 w. Autocar—July 27, 1901. No. 42512 A.

British Law.

The Maybach Carburetter Case. Discusses this case, which is of interest to the automobile industry, from the technical, legal, and commercial points of view. 7700 w. Auto Jour—Aug. 1901. No. 42931 A.

Electric Vehicles.

Electric Automobilism (L'Automobilisme Electrique). Felix Colomer. An examination of the availability of electric accumulators for driving motor vehicles with especial reference to the Contal accumulator. 2000 w. Revue Technique—Aug. 10, 1901. No. 42809 D.

The "Electricia" Carriages. From *La Nature.* An illustrated description of interesting features of these vehicles. 1300 w. Sci Am Sup—Aug. 17, 1901. No. 42670.

Endurance Test.

Road Description of the 500-Mile Endurance Test. Maps, road description and general instructions, as compiled by the committee having charge of this contest between New York and Buffalo. 6200 w. Auto Mag—Sept., 1901. No. 42925 C.

Fire Engines.

Self-Propelled Fire Engines. Waldon Fawcett. Illustration and information concerning these engines as used in Boston. 800 w. Sci Am—Aug. 17, 1901. No. 42669.

Fuel Feeding.

Feeding Fuel to Cylinder-Fired Motors. Hugh Dolnar. Illustrated information of appliances for regulating the flow, showing the superiority of these various mixing valves to the older forms of carburetters. 2200 w. Autocar—Aug. 10, 1901. No. 42-723 A.

Gasoline Vehicles.

Remodeling a Gasoline Vehicle. Albert L. Clough. Describes changes made and reasons for making them. 1000 w. Horseless Age—Aug. 21, 1901. No. 42763.

The Gasoline Carriage of the United States Long Distance Automobile Company. Illustrated description of a carriage of the intermediate class, both as regards weight and engine speed. 900 w. Horseless Age—Aug. 14, 1901. No. 42696.

The Kühlstein-Vollmer Gasoline Vehicle. Illustrated description of a vehicle made by these German manufacturers. 1300 w. Horseless Age—Aug. 7, 1901. No. 42586.

The Mercedes Carriage. Illustration and particulars of this powerful gasoline vehicle. 2700 w. Horseless Age—Aug. 21, 1901. No. 42762.

Motor.

The Kühlstein Vollmer Motor. From *Der Motorwagen.* Illustrated description. 700 w. Horseless Age—Aug. 28, 1901. No. 42963.

Motor Cars.

Some Work in the Development of a Motor-Car. M. Holroyd Smith. A description of the work involved in the construction of the latest Petrol car designed and built by the author, with deductions therefrom. 4 plates and other illustrations. 5500 w. Inst Mech Engrs—Aug., 1901. No. 42589 D.

The Gaillardet Motor Car. Illustrates and describes these vehicles which differ in details from most other manufacturers. 900 w. Auto Jour—Aug. 1901. No. 42933A.

Motor Cycles.

Reflections on Motor Cycles. Albert L. Clough. Conclusions of the writer after a 60-mile trip on a motor tricycle. 2000 w. Horseless Age—Aug. 7, 1901. No. 42585.

Musker System.

The Coke and Oil-Fired Musker System. Illustrated descriptions of the steam wagons of this firm, which took part in the recent heavy wagon trials at Liverpool. 1200 w. Auto Jour—Aug., 1901. No. 42932A.

Steam Carriage.

Working Drawings of a Steam Carriage. T. Hyler White in *The English Mechanic.* Begins the description of a carriage incorporating the latest ideas, and which may be built at a fairly low cost. 2000 w. Horseless Age—July 31, 1901. Serial. 1st part. No. 42463.

Thunderstorms.

Is an Autocar Safe in a Thunderstorm? Sidney F. Walker. Explains the electrical discharge during a thunderstorm, and the conditions needed for safety. 2500 w. Autocar—Aug. 17, 1901. No. 42926A.

Tires.

Side Stresses and Braking Efforts on Tires. Albert L. Clough. An examination of stresses which might occur in the use of motor vehicles. 1000 w. Horseless Age—July 31, 1901. No. 42462.

HYDRAULICS.

Centrifugal Pumps.

The Testing of Centrifugal Pumps (Beproeving van Kreiselpumpen). M. C. E. Bongaerts. A description of the Neukirch method, maintaining a constant level of head against the pump, the latter being driven by an electric motor. 1200 w. De Ingenieur—Aug. 10, 1901. No. 42849D.

Compression.

See Mining and Metallurgy, Iron and Steel.

Flow.

Comparison of Formulas for Flow of Water in Clean Cast-Iron Pipes. Frank S. Bailey. Gives a table of computed velocities and explanatory notes. 700 w. Eng News—Aug. 15, 1901. No. 42685.

Intensifiers.

Hydraulic Intensifiers. Gerald E. Flanagan. Explains what an intensifier is, and its operation. Ill. 900 w. Am. Mach—Aug. 22, 1901. No. 42766.

Plumbing.

The Plumber as a Sanitary Expert. James Allison. Explains why legislation is needed to control this industry, and the importance of education. 2500 w. Dom Engng—Aug. 15, 1901. No. 42702 C.

Plumbing in a New York Residence. Illustrated description of a job with an unusually simple arrangement of water piping and no kitchen and laundry boilers. 800 w. Eng Rec—Aug. 3, 1901. No. 42540.

Power Development.

The Water Power Plant of the Empire State Power Company. Illustrated description of a 3,000-H. P. plant on a 40 ft. fall, the water being carried from the dam through a long canal and short penstocks. Power is transmitted to Howes Cave and to Amsterdam, N. Y. 3400 w. Eng Rec—Aug. 10, 1901. No. 42614.

Pumping Engines.

Pumping Engines at Hampton. Detailed description of these engines, which are fully illustrated. 900 w. Engr, Lond—Aug. 2, 1901. No. 42652A.

The Riedler Pumping Engine. An account of an inspection of two pumps at work. Ill. 1600 w. Col Guard—Aug. 16, 1901. No. 42955A.

Ram.

A Large Hydraulic Ram. Daniel W. Mead. Describes the water-works system at West Dundee, Ill., and gives illustrated description of the hydraulic ram used to force the water into the tower. 1000 w. Eng Rec—Aug. 24, 1901. No. 42918.

Turbines.

Inward-Flow Turbines. Illustrated description of these turbines which, when tested, reached 85½ per cent. total efficiency. Also report of tests. 2400 w. Engr, Lond—Aug. 16, 1901. No. 42950A.

The 3000 Horse Power Turbines at Niagara (Die 3000-pferdigen Turbinen Am Niagara). R. Thomann. A detailed description of two horizontal Francis turbines built by Riva, Monneret & Co., of Milan, Italy, for the Hamilton Electric Light and Contract Power Co., of Canada. 1800 w. Zeitschr d Ver Deutscher Ing—Aug. 3, 1901. No. 42826 D.

MACHINE WORKS AND FOUNDRIES.

Angle Rolls.

The Design of Angle Rolls. William Hirst. Discusses important points in rolling, the designs of rolls for making angles, the early forms of passes, &c. Ill. 3700 w. Ir Age—Aug. 8, 1901. Serial. 1st part. No. 42570.

Boiler Making.

A Method of Developing the Slope Sheet of a Locomotive Boiler When Center of the Cone is Inaccessible. Frank B. Kleinhaus. Illustrated description of method used. 500 w. Loc Engng—Aug., 1901. No. 42443C.

On Circular, Stay-bolted Water Legs. A mathematical explanation of the method of deriving formulæ used in a former article, which have been criticized. 1600 w. Locomotive—June, 1901. No. 42672.

Brass Castings.

Thin Brass Castings. C. Vickers. Discusses the difficulties in this work, giving suggestions. 1000 w. Am Mach—Aug. 15, 1901. No. 42699.

Cast Iron.

Standard Specifications for Testing Cast Iron. Specifications adopted by the Am. Found. Assn., with recommendations of the committee relative to the molding of the test bars, &c. Ill. 2100 w. Jour Am Found Assn—June, 1901. No. 42656.

Cast-Iron Pipes.

French Practice in the Manufacture of Cast-Iron Pipes. A. G. Cloake. Read at meeting of Assn of W. Wks. Engrs. Describes the practical and workmanlike methods; the pipes are cast vertically. 2000 w. Arch't, Lond—Aug. 16, 1901. No. 42924A.

Cranes.

Cantilever Cranes at the Yard of William Cramp & Sons' Ship and Engine Building Company. Illustrated description of new equipment for handling materials consisting of three cantilever cranes driven by electricity and covering six shipways. 500 w. Marine Engng—Aug., 1901. No. 42495C.

Modern Heavy Harbour Cranes (Moderne Hafen und Werftkrane—Schwerster Konstruktion). H. Mehlis. With details and illustrations of the latest heavy wharf cranes at Hamburg, Bremen and other places. 2500 w. 2 plates. Glaser's Annalen—Aug. 15, 1901. No. 42831D.

Modern Lowering Brakes for Cranes (Kritik der Neueren Senksperrbremsen für Krane). Ad. Ernst. A description of the various forms of safety brakes for cranes and hoisting machinery by which the load may be lowered without danger. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—Aug. 3, 10, 1901. No. 42825 D.

Novel Cranes. Waldon Fawcett. Describes some recent modifications and improvements. Ill. 1100 w. Am Mfr—Aug. 15, 1901. No. 42683.

Dies.

A Combination Die for Shallow Rectangular Shells. William Doran. Illustrates and describes the design and construction. 2300 w. Am Mach—Aug. 29, 1901. No. 42966.

A Twisting Die. C. H. Rowe. Drawings and description of a die made for twisting the ends of sheet brass, 1/16 inch thick and 3/16 inch wide, but also adapted for other work. 700 w. Am Mach—Aug. 1, 1901. No. 42458.

Dies for Umbrella Rib Tips. William Doran. Illustrated description of dies for the work named and adapted for the rapid production of other small sheet-metal parts 900 w. Am Mach—Aug. 1, 1901. No. 42459.

Electric Driving.

See Electrical Engineering, Power Applications.

Forging Press.

Press of 1000 Tons Capacity for Compressing Steel Ingots (Presse de 1000 Tonnes pour la Compression de Lingots d'Acier). With sectional illustrations of the powerful press used at the St. Etienne Steel Works, France. 1800 w. Génie Civil—Aug. 10, 1901. No. 42804D.

Gun Mounting.

Vickers' Gun-Mounting Works at Barrow-in-Furness. Illustrated detailed description of the various departments of these extensive works. 5000 w. Engng—July 26, 1901. No. 42524A.

Lathes.

A Large German Crank Shaft Lathe. Half-tone and line engravings of what is believed to be the largest lathe that has been made. Description. 700 w. Am Mach—Aug. 29, 1901. No. 42964.

Design for Special Screw Cutting Lathe. M. W. Leech. Drawings and description of a design for cutting short fine threads used on mountings for instrument work. 350 w. Am Mach—Aug. 22, 1901. No. 42768.

Lathe for Double Crank Shafts (Doppelte Kurbelachsen-Drehbank). Illustrated description of heavy double ended lathe built by E. Schiess of Düsseldorf, for turning heavy multiple-crank shafts for marine engines. 1000 w. Stahl und Eisen—Aug. 1, 1901. No. 42840 D.

The Three-Bearing Lathe. A. H. Cleaves. Illustrates and describes a lathe called in the watch factory, a plate lathe. 400 w. Am Mach—Aug. 29, 1901. No. 42967.

Milling Machine.

A Screw-Milling Machine. Illustrates and describes machines for cutting screw threads entirely by the use of milling cutters. 1300 w. Am Mach—Aug 22, 1901. No. 42767.

Milling Tools.

A Device for Measuring Angle Cutters. Horace E. Hext. An account of methods attempted for determining accurately the angle of a milling cutter, with illustrated description of the device which gave satisfactory results. 1700 w. Am Mach—Aug. 1, 1901. No. 42460.

Molding.

Molding Gap Lathe Beds. George Buchanan. Illustrates and describes the method used. 800 w. Am Mach—Aug. 29, 1901. No. 42968.

Pig Iron.

Discussion on the Grading of Pig Iron. 19200 w. Jour Am Found Assn—June, 1901. No. 42657.

Shaft.

Crank Shaft (Kurbelwelle). Brief description, with full detailed drawing of a four-crank shaft for a marine engine made by the Oberbilk Steel Works, Düsseldorf, for Blohm & Voss. The cranks are arranged for counter balancing on the Schlick system. 500 w. 1 plate. Schiffbau—July 23, 1901. No. 42860 D.

Shearing.

Experiments on the Work of Machine Tools (Expériences sur le Travail des Machines-Outils). M. Codron. A study of the action of tools in shearing various metals with analysis of the external and internal forces. 8000 w. Bull Soc d' Encour—July 31, 1901. No. 42820G.

Shops.

American Machine-Shop Practice from a German View-Point. Peter Lüders. Discusses American manufacturing conditions, the equipment of the shops, organization, and the unity of engineer and workman. 2400 w. Engineering Magazine—Sept., 1901. No. 42896B.

The New Works of the Becker-Brainard Milling Machine Company. Illustrated detailed description of these works and some of the equipment. 2700 w. Mach, N. Y.—Aug., 1901. No. 42450.

Spacing.

Spacing for Prime Numbers on the Universal Milling Machine. G. Schneider. An explanation of three methods used by the writer. Ill. 2400 w. Am Mach—Aug. 8, 1901. No. 42571.

Spacing the Teeth of a Rack. Illustrates and describes a spacing attachment that will space the teeth of any diametral pitch. 500 w. Am Mach—Aug. 15, 1901. No. 42697.

Universal Joint.

A New Variable-Angle Joint (Sur un Nouveau Joint à Angle Variable). G. Koenigs. A description of an improvement on the Cardan joint, by means of which a uniform angular velocity is transmitted. 1000 w. Comptes Rendus, July 15, 1901. No. 42836 D.

Valves.

Discussion of Mechanical Versus Poppet Valves for Air Compressors. J. A. Coombs. A letter giving the views of an

English manufacturer of this class of machinery, with editorial. 1500 w. Compressed Air—Aug., 1901. No. 42673.

MATERIALS OF CONSTRUCTION.

Abrasives.

Abrasive Materials. Joseph Hyde Pratt. Considers all the natural products used for abrasives; also the artificial products of carborundum and crushed steel. 5700 w. Am Mfr—Aug. 1, 1901. Serial. 1st part. No. 42564.

Aluminum.

The Method and Results of the Study of Aluminum and its Alloys (Methoden und Resultate der Untersuchung des Aluminums und Seiner Abkömmlinge). Abstract of an address of Prof. Tetmaier before the Association for Testing Materials at Zurich. 2000 w. Stahl und Eisen—Aug. 1, 1901. No. 42841 D.

Testing.

Official Testing Laboratories (Les Laboratoires Officiels d'Essais). A comparative review of the official testing laboratories of Berlin, Munich, Dresden, Vienna, and Prague, with estimates for the establishment of a laboratory in Paris. 3000 w. Revue Technique—July 10, 1901. No. 42814 D.

The Drop Flexure Test for Metals (l'Essai des Metaux à la Flexion par Choe). M. G. Charpy. A discussion of experiments made upon nicked bars by use of a pendulum drop. The relation of such tests to other methods are discussed. 8000 w. 1 plate. Mem Soc Ing Civ de France—June, 1901. No. 42816 G.

Torsion.

The Determination of the Maximum Shearing Stress in a Bar Under Torsion (Bestimmung der Grössten Schubspannung in Querschnitt eines Geraden auf Drehung Beanspnichten Stabes). E. Autenrieth. A mathematical examination of the external and internal forces in a rod subjected to torsion. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 3, 1901. No. 42827 D.

POWER AND TRANSMISSION.

Coal Handling.

Modern Coal Handling Machinery. Waldon Fawcett. Reviews the recent improvements in apparatus for this purpose. Ill. 2000 w. Am Mfr—Aug. 22, 1901. No. 42788.

The Progress of Penarth Dock. Illustrated description of the movable coal tips recently opened, and their operation. 2300 w. Engr, Lond—July 26, 1901. No. 42-531 A.

Compressed Air.

The Billancourt Compressed Air Station (Usine de Billancourt pour la Production de l'Air Comprimé). G. Boeto. A fully illustrated description of the compressing station of the Paris Omnibus Company. 4000 w. 1 plate. Génie Civil—July 20, 1901. No. 42800 D.

Contractor's Plant.

The Contractor's Power Plants on the New York Rapid Transit Railway. Illustrated descriptions of eight stations, built as a rule in cramped situations, for supplying compressed air for hoisting engines, drills and other apparatus. 4200 w. Eng Rec—Aug. 3, 1901. No. 42538.

The Norwich Hydraulic Compressed Air Plant. Illustrated detailed description of an interesting plant to furnish compressed air through 3 miles of 16-inch plain cast-iron pipe to power users in Norwich. 2000 w. Eng Rec—Aug 24, 1901. No. 42916.

Conveyors.

Chain-Belt Conveyors for Wood-Working Plants. Illustrates and describes two special forms of conveyors for the handling of materials. 600 w. Eng News—Aug. 8, 1901. No. 42603.

Locomotive Coal and Ashes Handling Plant, Philadelphia and Reading Ry., Philadelphia, Pa. Illustrated description of the construction and operation. 800 w. Eng News—Aug. 15, 1901. No. 42688.

Gear Teeth.

The Effect of the Angle of Obliquity in Fixing the Interference Limits for Involute Teeth. Robert A. Bruce. Diagrams and explanation of the theory extended to cover the case of special pairs of wheels. 1200 w. Am Mach—Aug. 29, 1901. No. 42965.

SPECIAL MOTORS.

Binary Engine.

The Josse Waste Heat Engine. Illustrated description of an engine whose purpose is to utilize the waste heat of a steam engine. Editorial comments. 3300 w. Elec Wld & Engr—Aug. 10, 1901. No. 42628.

Gas Engines.

The Horse Power of Gas Engines. Discusses the need of a more definite and uniform basis of comparison. 1800 w. Prac Engr—Aug. 16, 1901. No. 42929 A.

Power Gas.

Gas Engines for Furnace Gas (Les Moteurs à Gas des Hauts Fourneaux). J. Deschamps. With illustrations of large gas engines used with furnace gases for driving blowing engines and for the production of power. Serial. 5000 w. Revue de Mécanique—July 31, 1901. No. 42-819 E + F.

STEAM ENGINEERING.

Accidents.

Water in Engine Cylinders. An account of accidents due to this cause, with suggestions for avoiding them. Ill. 1600 w. Power—August, 1901. No. 42454.

Blow-Off Tanks.

Blow-Off Tanks for Steam Boilers. Harold W. Barker. Discusses the damage to sewers from the hot water from boilers, and gives an illustrated description of a tank for cooling the water to a safe temperature before it enters the sewers. 600 w. Prac Engr—Aug. 16, 1901. No. 42928 A.

Boilers.

Navy Boilers. Editorial discussion of the letter from Mr. Delaunay Belleville, addressed to the Secretary of the British Admiralty, in defense of the Belleville boiler. 3500 w. Engng—July 26, 1901. No. 42526 A.

The Improved Boiler of F. Schichau of Elbing (Ein Neuer Kesseltyp der Firma F. Schichau in Elbing). Describing an improved form of water-tube boiler. especially adapted for marine use. 1200 w. Schiffbau—July 23, 1901. No. 42858 D.

The Marine Water-Tube Boiler. John Platt. Discusses their adaptability to large units and emergency service, and the excellent results obtained from their use in torpedo boats and destroyers where boilers are forced. Urges that more attention be paid to the possibilities of the express type of boiler. 2400 w. Engineering Magazine—September, 1901. No. 42892 B.

The Water-Tube Boiler Question in the German Navy. Translated and condensed article by Mr. Koehn von Jaski, published in the *Marine Rundschau*. Discusses the origin of the water-tube boiler question, reasons for their introduction, their disadvantages, choice of the systems, equipment of German vessels, experience, etc. 4000 w. Naut Gaz—Aug. 1, 1901. No. 42473.

The "Minerva" and "Hyacinth" Trials. Editorial on the trials of these cruisers, discussing the boilers as tested, with remarks on the ships, and their performance. 1100 w. Engng—July 26, 1901. No. 42527 A.

The "Minerva" and the "Hyacinth." Editorial discussion of the competitive trials of these cruisers. 1700 w. Engr Lond—July 26, 1901. No. 42532 A.

The Selection of a Steam Boiler. W. E. Snyder. Considers the generation of steam, the transference of the heat from the furnace to the boiler. Urging that the selection, construction and erection of the boilers be intrusted to a competent engineer of wide experience. 14400 w. Pro Engrs' Soc of W. Penn.—June, 1901. No. 42777 D.

Two New Water-Tube Boilers. Illustrates and describes the Parker water-tube boiler, and also the Hammond boiler. 1400 w. Eng News—Aug. 22, 1901. No. 42912.

Boiler Room.

Boiler Room Efficiencies. William D. Ennis. Discusses the losses and methods of securing a decrease in the waste. 3000 w. Am Elect'n—Aug., 1901. No. 42466.

Boiler Testing.

A Few Points on Practical Boiler Testing. John W. Fletcher. On the proper method of testing any boiler, land or marine, new or old. 700 w. Sci Am—Aug. 31, 1901. No. 42971.

Compression.

The Laws of Expansion and Compression (Sur les Lois de la Détente es de la Compression). V. Dwelshauvers-Dery & A. Duchesne. An examination of the principles involved in the compression of steam in an engine cylinder, with experiments sustaining the author's opinion of the wastefulness of clearance. 4000 w. Revue de Mécanique—July 31, 1901. No. 42818 E + F.

Exposition.

Steam Engines at the Paris Exposition (Die Dampfmaschinen der Pariser Weltausstellung). L. Czischek. The first of a series of illustrated articles describing the various steam engines exhibited at Paris, with critical comments. Serial. Part I. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—July 19, 1901. No. 42828 B.

The Engines of the Pan-American Exposition. Illustrated descriptions of engines exhibited in operation. 6000 w. Power—Aug., 1901. No. 42452.

Feed Water.

Acid in Monongahela River Water. J. A. Mohr. Discusses the use of water from this river, for boiler purposes, giving analyses, method of testing, &c., 1200 w. Pro Engrs' Soc of W. Penn.—June, 1901. No. 42778 D.

Fuel Oil.

Oil as a Fuel. William Kennedy, in *Southern Industrial and Lumber Review*. Discusses the effect of location on the cost, methods of burning, and the uses to which it may be applied. 2000 w. Am Gas Lgt Jour—Aug. 5, 1901. No. 42553.

Piston.

Centering a Piston. H. H. Kelley. Illustrated suggestions for doing this work. 2200 w. Engr, U. S. A.—Aug. 1, 1901. No. 42497.

Portable Engine.

Tests of the Wolf Compound Portable Engine (Bremsversuche an einer von R. Wolf Gebauten Heissdampf-Verbund lokomobile). Data and results of test of a compound portable engine using superheated steam. 2500 w. Zeitschr d Ver Deutscher Ing—July 27, 1901. No. 42824 D.

Scale.

The Chemistry of Deposits in Steam Boilers. W. E. Ridenour. Considers the physical appearance and vast amount of these accumulations, and discusses the chemical salts existing in these deposits. 1200 w. Jour Fr Inst—Aug., 1901. No 42488 D.

Smoke.

Smoky Furnaces and How to Avoid Them. W. H. Booth. The first of a series of articles proposing to deal with a few furnaces in use, with a view to showing how far they are constructed upon correct lines and in what points they may fail to effect perfect combustion. 2400 w. Elec Rev, Lond—July 25, 1901. Serial. 1st part. No. 42521 A.

Steam.

Power Steam. D. B. Dixon. On the nature and properties of steam. 2500 w Mod Mach—Aug., 1901. No. 42565.

Steam Engines.

How to increase the Horse-Power of a Steam Engine. D. B. Dixon. Discusses ways in which the horse-power can be increased. 1800 w. Am Mfr—Aug. 8, 1901. No. 42637.

The Experimental Study of the Steam Engine. John T. Nicholson. Lecture before the Engng Soc of the Owens College Union. 4000 w. Prac Engr—Aug 2, 1901. Serial. 1st part. No. 42640 A.

Steam Heating.

Steam Heat with Condensing Engines. Alton D. Adams. Discusses the use of the vacuum system of heating with steam from condensing engines and the work which may be done by exhaust steam. 1300 w. Sci Am—Aug. 24, 1901. No. 42772.

Valve Motion.

Valve Motion of Recent Passenger Locomotives. Gives a diagram of the valve motion of the "Central Atlantic" type locomotives, and calls attention to the remarkable uniformity of cut-off. 400 w. Am Engr & R R Jour—Aug., 1901. No. 42499 C.

Valves.

Throttle Valves for Steam Engines. W. H. Wakeman. Showing the advantages and disadvantages of some familiar types. Ill. 900 w. Engr, U. S. A.—Aug. 1, 1901. No. 42498.

MISCELLANY.

Aeronautics.

Motor Ballooning. Illustrates the apparatus of M. Santos-Dumont giving particulars of the mechanism and remarks on other machines by the same inventor. 1600 w. Autocar—July 27, 1901. No. 42513 A.

The Empire of the Air. Gives an illustrated description of the air ship used by M. Dumont in his last attempt to secure the Deutsch prize, with a review of the types of machines most likely to solve this problem. 2700 w. Auto Jour—Aug., 1901. No. 42930 A.

The Motor Balloonist's Escape. Concerning the accident to M. Santos-Dumont's air ship. 700 w. Autocar—Aug. 17, 1901. No. 42927 A.

The Santos-Dumont Navigable Balloon. An illustrated account of the work of M. Santos-Dumont in this field. 2500 w. Engr, Lond—July 26, 1901. No. 42530 A.

Ballistics.

The Law of Pressures in Guns (Sur la Loi des Pressions dans les Bonches à Feu). E. Vallier. An extension of the author's previous researches upon the relations of pressure and projectile velocity. 1200 w. Comptes Rendus—July 22, 1901. No. 42837 D.

Education.

A Founders' Trade School. Thomas D. West. Shows need of such a school because of the advancement in the art of founding; outlines the kind of school required and suggests the means of obtaining it. 1500 w. Ir Trd Rev—July 25, 1901. No. 42436.

Exhibitions.

Engineering at the Glasgow Exhibition. John G. Kerr. A finely illustrated article describing salient points in the steam plant and machinery section, and showing improvements of great importance. 3300 w. Engineering Magazine—Sept., 1901. No. 42899 B.

Mechanical and Electrical Features of the Pan-American Exposition. William S. Aldrich. Illustrates and describes the important appliances displayed, calling attention to the tendencies in recent development. 4800 w. Engineering Magazine—Sept., 1901. No. 42898 B.

The Engineering Organization of a Great Exposition. Georges Caye. Considers the services rendered by the engineering profession in the organization and administration of the Paris Exposition. Fully illustrated. 4000 w. Engineering Magazine. Sept., 1901. No. 42897 B.

Foreign Shipment.

Boxing Machine Tools for Foreign Shipment. J. M. Richardson. Considers some of the requirements in packing machinery to send abroad. 1800 w. Am Mach—Aug. 15, 1901. No. 42698.

Guns.

Modern Guns at the Pan-American Exposition. Grahame H. Powell. Illustrated description of the exhibit of guns used in the coast defense of the United States. 1800 w. Am Mach—Aug. 1, 1901. No. 42457.

Naval Ordnance. A. Trevor Dawson. Considers the structure of guns, the breech mechanism, the motive power for working large guns within turrets, mountings, guns to repel torpedo and submarine boat attack, projectiles, &c. 33 plates. 18300 w. Inst Mech Engrs—Aug., 1901. No. 42-590 D.

The 16-Inch Breech-Loading Rifle. Waldon Fawcett. Illustrated account of this gun and its construction. 1700 w. Am Mfr—Aug. 1, 1901. No. 42563.

Handling.

Moving a Cylinder. Illustrated directions for loading and unloading on cars or wagons. 2000 w. Power—Aug., 1901. No. 42453.

Invention.

A Century of American Invention. Leon Mead. Reviews the history of the patent system, pointing out the manner in which certain inventions have increased the world's commerce, added to the comfort of the human family, and enlarged the opportunities of labor. 3000 w. Gunton's Mag—Aug., 1901. No. 42486 C.

Oxygen.

Industrial Oxygen (L'Oxygen Industriel). Raoul Pictet. Describing an improved method for obtaining pure oxygen at a cost lower than that of common illuminating gas by fractional distillation of liquid air. The liquid air supply is continually replaced by the process. An important paper. 6000 w. Mem Soc Ing Civ de France—June, 1901. No. 42817 G.

Pyrometry.

A System of Corrections for Heat Losses in Calorimetric Experiments. Joseph W. Richards. Describes systems of corrections which have been used several years and given accurate and satisfactory results. 2300 w. Jour Fr Inst—Aug., 1901. No. 42487 D.

The Measurement of High Temperatures. S. Geijsbeek. Begins an outline of the principal apparatus in use and a review of the methods employed. Ill. 1100 w. Min Rept—Aug. 8, 1901. Serial. 1st part. No. 42630.

Sugar Machinery.

Notes on Erecting Sugar Machinery. From *Steam Engineering*. Describes the methods employed in building the foundations and erecting the apparatus. Ill. 1700 w. Mach, N. Y.—Aug., 1901. No. 42451.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Fatal Accidents in Coal Mining in North America. Frederick L. Hoffman. Comparative statistics covering the last decade, showing the fatalities in 1900 to be greater than in any other year. 1200 w. Eng & Min Jour—Aug. 10, 1901. No. 42598.

Alabama.

The Mineral District of Alabama. An illustrated article reviewing its resources in iron and coal. 5500 w. Ir & Coal Trds Rev—Aug. 9, 1901. No. 42740 A.

Balance Platform.

Notes on a Briart Balance Platform Installed at Shaft No. 6 at Gorlooka, South Russia. A. Lebrun. Illustrated description of the apparatus with a statement of its advantages. 1200 w. Ir & Coal Trds Rev—Aug. 16, 1901. No. 42948 A.

Coal-Fields.

The Allegheny Valley Coal-Fields. William Gilbert Irwin. Concerning these productive fields as recently developed. 1200 w. Eng & Min Jour—Aug. 24, 1901. No. 42790.

Coals.

See Gas Works Engineering.

Dredging.

Dredging for Coal. An illustrated description of the method of mining in the Mission Field Coal Mine, Illinois, by the use of the steam shovel cableway. 1500 w. Mines & Min—Aug., 1901. No. 42-621 C.

Haulage.

A Lancashire Electrical Haulage Plant. Illustrates and describes a plant at Breightmet Colliery, near Bolton, as a type of the ease with which electricity may be applied to mining machinery. 800 w. Col Guard—July 26, 1901. No. 42-523 A.

India.

Indian Coal. Editorial discussion of the opening of coal mines in different parts of India, because of the high price of English coal. 1200 w. Engng—Aug. 16, 1901. No. 42958 A.

Machine Cutting.

Coal Cutting by Machinery. Ernest Kilburn Scott. Contributed to the Inst. of Civ. Engrs. Reviews the history of mechanical coal cutting, giving illustrated descriptions of the various types of machines, and discussing the process used. 6500 w. Ir & Coal Trds Rev—Aug. 16, 1901. No. 42945 A.

Nineteenth Century.

Coal Mining in the Nineteenth Century. W. Blakemore. Read before the Applied Science Society of McGill Univ. Gives statistics of production, discussing the remarkable development, economic considerations, effect on transportation, improved methods, &c., referring especially to Canada. 7500 w. Can Engr—Aug., 1901. No. 42566.

Ohio Coal.

The Economic Value of the Clarion Coal in Vinton and Jackson Counties, Ohio. N. W. Lord. Abstract of a paper read before the Ohio Inst. of Min. Engrs. Describes tests made of these coals, and gives results. 1400 w. Eng News—Aug. 22, 1901. No. 42908.

Production.

The Coal Production of the Principal Countries of the World. Statistics from the report of the British Board of Trade. 2700 w. Col Guard—July 26, 1901. No. 42522 A.

Screening and Washing.

New Coal-Screening and Washing Plant at a Belgian Colliery. J. de Jaer. From *the Annals des Mines de Belgique.* Illustrated description. 800 w. Col Guard—Aug. 16, 1901. No. 42956 A.

Trans-Mississippi Coals.

The Stratigraphical Location of Named Trans-Mississippian Coals. Charles R. Keys. Gives the original localities. 1200 w. Eng & Min Jour—Aug. 17, 1901. No. 42707.

Workings.

A Modified Longwall System. Clarence R. Claghorn. Read before the Cen. Min. Inst. of W. Penn. Illustrated notes on the method employed at the Vintondale mine of the Vinton Colliery Company. 3500 w. Mines & Min—Aug., 1901. No. 42624 C.

COPPER.

Arizona.

The Verde Mining District, Arizona. John Jewett. Reviews the situation and prospects of the copper mines of this district. Ill. 2000 w. Eng & Min Jour—Aug. 10, 1901. No. 42600.

Concentration.

Comparison of Fire with Water for Concentration. S. E. Bretherton. Claims that in copper smelting the "fire process" is driving the wet concentration process to handle only extremely siliceous ores low in values. 1200 w. Min & Sci Pr—Aug. 24, 1901. No. 42961.

Ore Treatment.

Treatment of Low-Grade Copper Ores. An account of the Doetsch process used at the Rio Tinto mines in Spain. 900 w. Min Rept—Aug. 1, 1901. No. 42537.

Refining.

Electric Copper Refining. George E. Walsh. On the processes employed and the further preparation for commercial purposes. 1800 w. Elec Rev, N. Y.—Aug. 24, 1901. No. 42785.

GOLD AND SILVER.

Alaska.

Mining along the Alaska Coast—Ketchikan, Alaska—The Atlin Country. W. M. Brewer. An account of a recent visit to these regions, with reports of the mining conditions. 3500 w. Eng & Min Jour—Aug. 24, 1901. No. 42792.

Dominion Assay Office in Vancouver. Alfred W. Dyer. Describes the office and the process; the operations are conducted in full view of the depositor of gold dust. 2300 w. B. C. Min Rec—Aug., 1901. No. 42658 B.

Beach Sands.

Auriferous Beach Sands of British Columbia. General information concerning these deposits and the attempts to work them, the machines used, &c. Ill. 5000 w. B. C. Min Rec—Aug., 1901. No. 42659 B.

Cyaniding.

Cyaniding Cupriferous Ores. L. Janin, Jr. Describes the treatment of these ores in the Transvaal. It depends upon the property of cupro-cyanide of potassium to dissolve a small quantity of copper in the form of sub-cyanide, which is then precipitated. 1100 w. Eng & Min Jour—Aug. 17, 1901. No. 42706.

Extraction.

Electrolytic Gold Extraction. An illustrated description of the Reicken process, describing the apparatus. 2500 w. Aust Min Stand—July 18, 1901. Serial. 1st part. No. 42729 B.

Fine Gold.

Method of Saving Fine Gold of Snake River, Idaho. William H. Washburn. Gives a brief description of some of the methods which have led to the processes now most successfully used. 2500 w. Min & Sci Pr—Aug. 3, 1901. No. 42575.

India.

The Kolar Gold Fields. Reviews the history of gold recovery in India. The first article is introductory. 2500 w. Ind & East Engr—July, 1901. Serial. 1st part. No. 42716 B.

Nineteenth Century.

The Gold Standard and the Gold Production in the Nineteenth Century. Horace White. Concerning the adoption of the single gold standard by the most important countries of the civilized world; the production, discoveries, &c. 1800 w. W. Min Wld—Aug. 3, 1901. No. 42569.

Siberia.

The Gold Mines of Siberia. Chester Wells Purington. Illustrated description of the primitive methods used in what promises to be an exceedingly rich region. 2400 w. Engineering Magazine—Sept., 1901. No. 42894 B.

Stamp Mills.

Stamp Mill Construction. J. J. Deming. Discusses the inprovement made and the important principles of good construction. 4000 w. W. Min Wld—Aug. 17, 1901. No. 42741.

Sulphides.

The Sulphide Ore Problem. Jas. W. Worsey. Begins a discussion of the systems of treatment used with zinciferous lead sulphides. 900 w. Min & Sci Pr—Aug. 3, 1901. Serial. 1st part. No. 42574.

Tasmania.

North Mount Farrell Silver-Lead Mine. An illustrated account of the discovery and development. 1800 w. Aust Min Stand—June 27, 1901. No. 42664 B.

IRON AND STEEL.

Angle Rolls.

See Mechanical Engineering, Machine Works and Foundries.

Blast Stoves.

Brick Blast-Heating Stoves (Steinerne Winderhitzer). F. W. Lürmann. A discussion of the construction, the behaviour of bricks used in the checkerwork of hot blast stoves with data of tests, showing the importance of using high-grade material. 3500 w. Stahl und Eisen—Aug. 1, 1901. No. 42838 D.

Casting Machine.

Pig Iron Casting Machines (Roheisen Giessmaschinen). E. Belain. A description of the Ramsey machine, which differs from that of Uehling in having the moulds on the periphery of a large wheel, instead of being carried on a chain gear. 1200 w. Stahl und Eisen—Aug. 15, 1901. No. 42843 D.

Compression.

The Compression of Steel (Dichten des Stahls). A. W. Zdanowicz. A description of the hydraulic machinery for compressing steel ingots, as used at the St. Etienne works in France. 3500 w. Stahl und Eisen—Aug. 15, 1901. No. 42844 D.

Furnaces.

Open-Hearth Steel Melting Furnaces. Brief illustrated description of the Wellman rolling open-hearth furnaces. 900 w. Sci Am Sup—Aug. 3, 1901. No. 42477.

Iron Smelting.

Iron Smelting at Nowa Nowa, (V.). Henry C. Jenkins. From the report of the government metallurgist, giving information concerning conditions and cost. 1500 w. Aust Min Stand—July 4, 1901. Serial. 1st part. No. 42665 B.

Japan.

Japanese Iron Works (Ueber den Japanischen Eisenhüttenbetrieb). A. Ledebur. With illustrations of mines, furnaces and primitive equipment. 2500 w. Stahl und Eisen—Aug. 15, 1901. No. 42842 D.

Phase Theory.

Iron and Steel from the Standpoint of the Phase Theory (Eisen und Stahl vom Standpunkte der Phasenlehr). H. von Jüptner. A review of the theory of Roozeboom, with reference to the criticisms of Osmond and Le Chatelier. 2500 w. Stahl und Eisen—Aug. 1, 1901. No. 42839 D.

Rail Steel.

Rail Steel. With Especial Reference to Its Hardness. Sectional discussion from the *Bulletin* of the International, Ry., Cong., summarizing the reports on the "Nature of Metals for Rails," and giving views of eminent authorities. 5300 w. R R Gaz—Aug. 23, 1901. No. 42914.

Separating.

Magnetic Ore Separating at Pitkäranta in Finland (Die Magnetische Erzaufbereitung zu Pitkäranta in Finland). G. Gröndal. A description of the use of the author's magnetic separator with the magnetic ores of Finland. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 10, 1901. No. 42857 B.

Spain.

Notes on the Iron Ore Deposits of Bilbao, Northern Spain. Frank D. Adams. Read before the Applied Science Society of McGill Univ. Information concerning these deposits, their value, the workings, &c. 2800 w. Can Engr—Aug., 1901. No. 42567.

Tropenas Process.

The Tropenas Converter Steel Process. A. Tropenas. Illustrated description of the process with information concerning it. 3200 w. Jour Am Found Assn—Sept., 1901. No. 42960.

MINING.

Accounts.

Mine Account Keeping and the Monthly Statement of Costs, as adapted to the Business of Metalliferous Mining. Charles V. Jenkins. Describes a thorough system of bookkeeping showing its value.

10300 w. Mines & Min—Aug., 1901. No. 42622 C.

Boring.

Boring for Natural Inflammable Gas, Oil, &c. Illustrates modern tools and describes methods. 1300 w. Am Gas Lgt Jour—Aug. 5, 1901. No. 42552.

British Columbia.

Mining in British Columbia. E. Jacobs. Review of this important industry, especially the development during the last ten years. 3000 w. B C Min Rec—Aug., 1901. No. 42660 B.

Colorado.

Twenty-five years' Progress in Colorado. Thomas F. Walsh. Address at a banquet at Colorado Springs. A summary of the mineral development of that State and the general progress. 2000 w. Min Rept—Aug. 8, 1901. No. 42629.

Electric Hoists.

See Electrical Engineering, Power Applications.

Explosion.

Official Report on the Blaendare Explosion. Presents reports by S. T. Evans and Joseph S. Martin on the circumstances attending the explosion by firedamp, which occurred on Feb. 28, 1901. Ill. 3000 w. Col Guard—Aug. 2, 1901. No. 42655 A.

Explosives.

Explosives in Coal Mines. Considers British legislation and the "permitted list" of explosives, discussing who should be held responsible in case of accident with these explosives. 1700 w. Col Guard—Aug. 2, 1901. No. 42653 A.

Practical Means of Testing Explosives. P. Chalon. Abstracts from an article in the *Revue Technique*. Reviews the behavior of explosives and methods of testing to determine their strength. 1400 w. Min Rept—Aug. 15, 1901. No. 42703.

Exposition.

The Pan-American Exposition. A general description of the grounds, etc., with special reference to the mining and engineering exhibits. Ill. 4800 w. Mines & Min—Aug., 1901. No. 42626 C.

Fans.

Description of, and Experiments with, M. Guibal's Fan. John W. Robinson. From the *Jour. of the Brit. Soc. of Min. Students*. 1800 w. Ir & Coal Trds Rev—Aug. 16, 1901. No. 42947 A.

Faults.

Faults.—Displacements. J. P. Wallace. Explains the occurrence of faults, and gives rules for recovering faulted veins. 1600 w. Min Rept—Aug. 22, 1901. No. 42787.

Firedamp.

The Firedamp Explosion in the Pluto Shaft at Wiesa (Die Schlagwetter Explosionen auf den Pluto schächten in Wiesa). F. Okorn. Abstract of the official report upon the fatal explosion of Nov. 13, 1900. Serial. Part 1. 1500 w. Two plates. Oesterr Zeitschr f Berg u Hüttenwesen—July 20, 1901. No. 42856 B.

Lodes.

The Pennsylvania M. Co. vs. Grass Valley Exploration Co., Litigation. Gives views of models used in this legal contest, showing interesting phenomena of lode occurrence, with explanation. 1000 w. Min & Sci Pr—Aug. 3, 1901. No. 42573.

Mexico.

Mexico's Progress in Mining Matters. William M. Courtis. Illustrates and describes a rich region that is being opened, the difficulties of transportation, and some of the work accomplished. 3200 w. Mines & Min—Aug., 1901. No. 42620 C.

Mine Cars.

Steel Mine Cars. M. G. Moore. Illustrates forms of construction and gives comparison of weights of steel cars with wooden cars of like capacities. 2000 w. Mines & Min—Aug., 1901. No. 42623 C.

Mining Plant.

See Electrical Engineering, Power Applications.

New Guinea.

Mining at Woodlark Island. M. Lobel. An account of this portion of British New Guinea, reporting great mineral resources, but a very trying climate. 2500 w. Aust Min Stand—July 18, 1901. No. 42727 B.

Ontario.

Mining in Eastern Ontario. Courtenay De Kalb. A review of the condition of the mining industry, reporting the conditions of various mining properties. 6000 w. Can Min Rev—July 31. 1901. No. 42505 B.

Mining in Ontario. Information from the annual report of the bureau of mines of Ontario, showing the great advancement made during the last few years, the output, value, &c. 1100 w. U. S. Cons Repts, No. 1119—Aug. 21, 1901. No. 42-738 D.

Pumping.

See Electrical Engineering, Power Applications.

Safety Catches.

The Theory of Safety Catches (Theorie der Fangvorrichtungen). R. A. Henry. A discussion of the action of safety catches on mine hoists, showing their application to an improved construction in connection with a hydraulic brake. Two articles, 7500 w. Two plates. Glückauf—Aug. 3, 10, 1901. No. 42855 each B.

Shaft Sinking.

High Speed Rotary Hydraulic Shaft-Boring Machine. G. Schneiders, in *Glückauf*. Illustrated description of the machine and its operation. 1100 w. Col Guard—Aug. 2, 1901. No. 42654 A.

The Future of Shaft Sinking (Zukunft und Zeile der Schachtbohrtechnik). G. Schneiders. Discussing the Kind-Chandron system and also an improved system with hydraulic removal of material. 5000 w. Two plates. Glückauf—July 27, 1901. No. 42854 B.

Veins.

Vein Definition. A summary of the definitions and opinions submitted by Ross E. Browne in the course of testimony in a recent trial. Ill. 4000 w. Min & Sci Pr—Aug. 17, 1901. No. 42743.

Well Boring.

Well Boring Machinery in Australia. W. Gibbons Cox. Treats of the machinery and apparatus now used, briefly reviewing the development. 3400 w. Engr Lond—Aug. 9, 1901. No. 42735 A.

Winding.

Enclosing a Ventilating Shaft for Winding Purposes. Illustrates and describes the arrangements at Neumühl Colliery to prevent waste of air during the operation of winding. 600 w. Col Guard—Aug. 9, 1901. No. 42739 A.

Wide Lodes.

Some Methods of Limbering and Working Wide Lodes in New South Wales. J. R. Godfrey. Abstract of paper read before the Australian Min. Engrs. An illustrated study of cases of actual mining when local conditions require special methods. 2300 w. Eng & Min Jour—Aug. 17, 1901. Serial. 1st part. No. 42708

MISCELLANY.

Abuse of Coal.

The Use and Abuse of Coal. Discusses coal as a fuel for brick burning in particular. 3300 w. Brick—Aug., 1901. No. 42561.

Analysis.

The Determination of Arsenic, Antimony, Tin and Bismuth in Fine Lead. M. Liebschutz. Describes method in detail. 1000 w. Eng & Min Jour—Aug. 10, 1901. No. 42599.

Aluminothermy.

Metals as Fuel. Sir W. Roberts-Austen. Abstract of a discourse delivered at the Royal Inst. Shows that metals may be burnt for the sake of the heat and light they produce. Ill. 5200 w. Nature—Aug. 8, 1901. No. 42722

Antimony.

The West Gore Antimony Deposits. W. R. Askwith. Brief description of the deposits in Nova Scotia. Ill. 1600 w. Can Min Rev—July 31, 1901. No. 42503 B.

Cadmium.

The Quantitative Determination of Cadmium. Edmund H. Miller and Robert W. Page. Describes work on a solution of cadmium chloride. The methods compared are the electrolytic, the carbonate and the phosphate. 2000 w. Sch of Mines Qr—July, 1901. No. 42744 D.

Coal-Tar.

Derivatives of Coal Tar. Condensed from the *Revue Technique*. An account of the distillation, refining and laboratory work. 5500 w. Pro Age—Aug. 15, 1901. No. 42671.

Corundum.

Corundum Deposits of Canada. Information concerning valuable and easily worked deposits recently discovered. 300 w. U. S. Cons Repts, No. 1102—Aug. 1, 1901. No. 42470 D.

Diamonds.

Diamonds in New South Wales. Information concerning the diamond fields, the stones found, etc. 500 w. U. S. Cons Repts, No. 1102—Aug. 1, 1901. No. 42469 D.

Metallurgical Fuels.

Present Day Metallurgical Fuels. Percy Longmuir. Deals with fuels of industrial interests both natural and artificial. 2500 w. Ir Trd Rev—Aug. 22, 1901. No. 42764.

Petroleum.

Petroleum—Something of Its History. James W. Drape, in *Stowell's Petroleum Reporter*. An interesting historical review. 2500 w. Am Gas Lgt Jour—Aug. 5, 1901. No. 42554.

The Present Condition of the Petroleum Industry in California. W. G. Young. A general summary of present conditions of these large deposits. 1500 w. Eng & Min Jour—Aug. 24, 1901. No. 42791.

Potters Clay.

Potters Clay at Middle Musquodoboit. F. H. Mason. Read before the Min Soc. of Nova Scotia. Describes the deposits and tests made. 1000 w. Can Min Rev—July 31, 1901. No. 42504 B.

Sapphires.

Sapphire Mining, Yogo, Montana. An illustrated description of these valuable deposits and the methods of mining. 1400 w. Min & Sci Pr—July 27, 1901. No. 42464.

Sweden.

See Industrial Economics.

Tariff.

See Industrial Economics.

RAILWAYS AND TRAMWAYS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in June. Detailed list and classified summary; 211 accidents in which 67 persons were killed and 241 injured. 4500 w. R R Gaz—Aug. 2, 1901. No. 42511.

Dispatching.

Two Methods of Dispatching on Interurban Electric Railways. Describes two methods quite different in principle, one used by the Union Traction Co. of Indiana, and the other by the Toledo, Fremont & Norwalk R. R. Ill. 2800 w. St Ry Rev—Aug. 15, 1901. No. 42715 C.

Transferring Freight.

Transferring Grain from Boats to Cars at Hickman, Ky. Abstract of an article by C. B. Wilson, contributed to the Trans. of the Engng Assn. of the South, showing one of the methods used for transporting freight from river steamers to the railways. Ill. 1000 w. Eng News—Aug. 1, 1901. No. 42483.

MOTIVE POWER AND EQUIPMENT.

Acetylene.

See Gas Works Engineering.

Alpine Road.

The Davos—Schatzalp Railway (Die Davos-Platz—Schatzalp Bahn). C. Wetzel. Describing the electrically operated cable road from Davos, Switzerland, to the sanitarium on the Schatzalp, 300 metres above. Serial. Part 1. 1000 w. Schweizerische Bauzeitung—Aug. 17, 1901. No. 42852 B.

Baltimore, Md.

The Street Railway System of Baltimore. An illustrated account of important changes and additions which have greatly improved the system. 5000 w. St Ry Rev—Aug. 15, 1901. No. 42713 C.

Berlin.

High Speed Electric Traction at Berlin. A concise statement of what has been undertaken at Berlin by the experimenters in this field, what has been accomplished, and what remains to be done. 900 w. U. S. Cons. Repts, No. 1103—Aug. 2, 1901. No. 42471 D.

Boiler Explosion.

The Knottingley Boiler Explosion. An account of the explosion of a new locomotive on the Lancashire and Yorkshire Railway, on the 11th of last March, with editorial. 6300 w. Ill. Engr. Lond—Aug. 9, 1901. No. 42737 A.

Boston Elevated.

Operating Features of the Boston Elevated. Francis H. Shepard. An illustrated article calling attention to interesting features of operation. 3000 w. Elec Wld & Engr—Aug. 10, 1901. No. 42627.

Brake Shoes.

The M. C. B. Brake-Shoe Tests. F. W. Sargent. Diagrams giving records of tests arranged with the speed constant and the loads varying, with discussion of points of interest. 2400 w. R R Gaz—Aug. 9, 1901. No. 42609.

Caboose.

A Chesapeake & Ohio Standard Caboose. Illustrated description of a design especially adapted to the needs of this road. 800 w. Ry Age—Aug. 9, 1901. No. 42661.

Cars.

80,000 Lbs. Capacity Drop Bottom Coal Car—Pittsburgh Coal Co. Illustrated description of a design from which 500 cars are being built. 1000 w. R R Gaz—Aug. 23, 1901. No. 42915.

50-Ton Twin-Hopper Car with Rolled Steel Underframe—Northern Pacific. Illustrated description. 700 w. R R Gaz—Aug. 9, 1901. No. 42612.

Low-Side Gondola Car for the Union Steel Company. Drawings and description with data from the calculations of stresses. 500 w. R R Gaz—Aug. 2, 1901. No. 42508.

Cleaning.

Proper Method of Cleaning Brake Cylinders and Triple Valves of Freight Cars. Otto Best. Directions for the cleaning and testing of triple valves and cylinders. Ill. 4400 w. Ry & Engng Rev—Aug. 24, 1901. No. 42794.

Controllers.

Traction Controllers (Zugsteuerungen). M. Kubierschky. A description of a system of controlling a number of motor cars from one controller on the Sprague principle, this being by the Union Electric Works of Berlin. 4000 w. Elektrotech Zeitschr—July 11, 1901. No. 42862 B.

Coupling.

The Conversion of the European Screw-Coupling into the American Coupling (Die Umwandlung der Europäischen Schraubenkuppelung in die Amerikanische Mittelbuffer-Kuppelung). J. Grimme. Illustrating an arrangement by which hooks of the Janney type are combined with the screw form, to aid in the transition. 1500 w. Glasers Annalen—Aug. 15, 1901. No. 42832 D.

Driver Brakes.

An Automatic Pressure Retainer for Driver Brakes. J. E. Muhlfeld. Drawings and description of a device in use on the Grand Trunk Ry., with a statement of its advantages. 1200 w. R R Gaz—Aug. 16. 1901. No. 42681.

Dublin.

The Dublin United Tramway System. A detailed account of the present condition and gradual development. Ill. 1800 w. Elect'n, Lond—Aug. 9, 1901. Serial. 1st part. No. 42724 A.

East Ham.

East Ham Electric Tramways and Lighting Installation. Illustrated detailed description of the first municipal electric tramway system in the Metropolitan district of London. 2500 w. Tram & Ry Wld—July 11. 1901. No. 42534 B.

Electric Traction.

High-Speed Electric Traction Between Milan and the Italian Lakes. Illustrates and describes the line, its operation, the steam generating plant, sub-stations, rolling stock, &c. 3800 w. St Ry Jour—Aug. 3, 1901. No. 42550 D.

Electricity vs. Steam.

The Supersession of the Steam Locomotive. W. E. Warrilow. Discusses the scheme proposed by Mr. Langdon in his paper "The Supersession of the Steam by the Electric Locomotive," and does not favor the conversion of the steam railway to the electric. 2800 w. Elec Engr, Lond—Aug. 16, 1901. No. 42935 A.

Electric Locomotive.

The Electric Locomotives of the Orleans Railway (Locomotives Electriques de la Compagnie des Chemins de Fer d'Orleans). An illustrated description of the locomotives for hauling the trains on the new extension of the Orleans railway in Paris. 1800 w. Revue Technique—July 10, 1901. No. 42810 D.

Electric Railways.

Wide and Narrow Gauge Electric Railways (Ueber Elektrische Vollund Schnellbahnen). Max Schiemann. A discussion of the problem of the application of electric driving to main line railways, in view of what has already been accomplished in tramways. 4500 w. Elektrotech Zeitschr—July 25, 1901. No. 42868 B.

Headlights.

Electric Headlights. An explanation of the care and management of these lights. 1500 w. Loc Engng—Aug., 1901. No. 42445 C.

Hubs.

Strength of Cast Iron Hubs. George L. Fowler. A report of experimental investigations to determine the bursting strength of some cast-iron hubs to be used in railroad service, where it was desired to use the thinnest metal possible. 2700 w. Ry Age—Aug. 23, 1901. No. 42780.

Indicator.

A Simple Locomotive Engine Indicator. Illustrated description of a device of considerable value, invented by Eric Norden. 350 w. Sci Am—Aug. 24, 1901. No. 42770.

Italy.

Heavy Electric Traction in the North of Italy. Enrico Bignami. Illustrated account of the projects under way and experiments in progress. 1200 w. Elec Rev, N. Y.—Aug. 10, 1901. No. 42597.

Locomotives.

American Locomotives and Foreign Buyers. S. R. Calloway. Reprint from the *Saturday Evening Post* of Philadelphia. On the recent criticisms of American locomotives sent to England. 3000 w. Ry & Engng Rev—Aug. 10, 1901. No. 42663.

Compound Express Engine, Hungarian State Railways. Illustrated detailed description of an engine exhibited at Paris, which possesses novel features. 1800 w. Engr, Lond—Aug. 9, 1901. No. 42736 A.

Coupled Express Engines on the Great Western Railway. Charles Rous-Marten. Explains the origin of the Atbara class of engines, and also discusses the Badminton and Camel classes. Reports concerning their operation. Ill. 2000 w. Engr, Lond—Aug. 2, 1901. No. 42649 A.

Explosions of Historical Locomotives. Reviews explosions of interest since the earliest use of locomotives. 1500 w. Engr, Lond—Aug. 2, 1901. No. 42650 A.

Freight Locomotive for Heavy Grades. Illustration and description of an engine of the Canadian Pacific R. R., of great tractive power, successfully used on grades of exceptional severity. 700 w. Sci Am—Aug. 24, 1901. No. 42769.

Inspection Locomotive—Chicago, Burlington and Quincy Railroad. Brief illustrated description. 300 w. Am Engr & R R Jour—Aug., 1901. No. 42500 C.

The Newest Six-Coupled Express Engines on the North-Eastern Railway. Charles Rous-Marten. Describes the new engine No. 2111 and gives a report of work accomplished by it. 3000 w. Engr, Lond—July 26, 1901. No. 42528 A.

The Tractive Power of Locomotives. W. F. M. Goss. Offered in discussion of a paper by G. R. Henderson on "A Practical Tonnage Rating," at the Mas. Mech's Con., June, 1901. 700 w. R R Gaz—Aug. 16, 1901. No. 42677.

London Tramways.

The Electric Trolley Lines of London. Illustrates and describes the model power house, showing the latest tramway work in England. 3800 w. Elec, N. Y.—Aug. 14, 1901. No. 42666.

Newcastle-on-Tyne.

Neptune Bank Power Station at Newcastle-on-Tyne. Illustrated detailed description of a station designed to supply electric energy for industrial purposes, lighting and traction. 5300 w. Tram & Ry Wld—July 11, 1901. No. 42535 B.

Open Cars.

New Style Open Cars in Montreal. Brief illustrated description of a novel type having one side open and the other closed. 700 w. St Ry Rev—Aug. 15, 1901. No. 42714 C.

Paris.

The Paris Metropolitan Railway (Le Métropolitain de Paris). A. Dumas. A review of the experience with the section now in operation and a description of the portions projected and under construction. The new carriages are shown. 2000 w. Génie Civil—July 20, 1901. No. 42801 D.

Railway Plant.

The Electric Plant of the Orleans Railway (Installations Electriques de la Compagnie des Chemins de Fer d'Orleans). A general description of the generating station for the operation of the electric section between the Pont d'Austerlitz and the Quai d' Orsay, Paris. 2500 w. Revue Technique—Aug. 10, 1901. No. 42807 D.

Rolling Stock.

Rhodesian Railway Rolling Stock. Illustrates typical cars, giving brief description. 500 w. Engng—Aug. 9, 1901. No. 42732 A.

Switzerland.

Electrical Distribution of the Bex-Gryon-Villars Railway (Distribution d'Energie Electrique et Chemin de Fer de Bex-Gryon-Villars). K. A. Breuer. With a description of the Sublin hydro-electric station of 1600 h. p., and the distribution of current for traction and power among villages in the Rhone valley. Serial. Part I. 3000 w. 1 plate. Génie Civil—Aug. 10, 1901. No. 42803 D.

Tramway Line.

The Holland-Friesland Line and the Lemmer-Joure Steam Tramway (De Holland-Friesland-Lijn en de Stoomtram Lemmer-Joure). With description of the steamboats and dock at Lemmer, and an account of the opening of the new tramway line. 3000 w. De Ingenieur—Aug. 17, 1901. No. 42850 D.

Underground.

The Electrical Equipment of the District and Metropolitan Railways. Charles T. Yerkes. Letter to the London *Times* explaining the position of the company represented by the writer. 1500 w. Elect'n, Lond—Aug. 2, 1901. No. 42643 A.

Underground Railways in London. Report from the Joint Select Committee of the House of Lords and House of Commons, recently issued. 3000 w. Archt, Lond—Aug. 2, 1901. No. 42639 A.

Unloading Rails.

Unloading Rails, Chicago, Milwaukee & St. Paul Ry. Illustrated description of the method used on this road. 900 w. Ry Engng Rev—Aug. 24, 1901. No. 42795.

Valteline.

The Valteline Electric Railway (Le Chemin de Fer Electrique de la Valteline). A general description of the application of three-phase electric traction to 106 kilometres of main railway between Lecco and Sondrio, Italy. The Ganz system is employed. 2000 w. Revue Technique—Aug. 10, 1901. No. 42808 D.

Valve Motion.

Locomotive Valve Motion. S. J. Dillon. Abstract of a talk given to engineers and firemen of the Pennsylvania Railroad. 800 w. Loc Engng—Aug., 1901. Serial. 1st part. No. 42444 C.

PERMANENT WAY AND FIXTURES.

Ballasting.

Ballasting New Railways. Abstract of an article by J. C. Rockhold, in the *Roadmaster and Foreman*. Advocates ballasting with plenty of good earth until the roadbed has become consolidated enough for permanent ballast. 1300 w. Eng News—Aug. 22, 1901. No. 42910.

Car House.

A New Car House for Brooklyn of Novel Design. Illustrates and describes the proposed structure. 800 w. St Ry Jour—Aug. 3, 1901. No. 42548 D.

Construction.

Methods of Safety for the Overhead Electric Trolley System. Edward Manville. Read before the Incor. Assn. of Munic. & Co. Engrs. Considers the precautions to be taken to ensure solid construction and methods of ensuring safety should a breakdown occur. Ill. 3800 w. Tram & Ry Wld—July 11, 1901. No. 42536 B.

Crossings.

The Abolition of Railroad Crossings at Grade. From the report of L. M. Hastings, offering plans for solving the various problems arising and making his recommendations. Ills. 2200 w. Munic Engng—Aug., 1901. No. 42558 C.

Electric Incline.

Palermo-Monreale Electric Incline. Illustrated description of this recently completed and novel road. 1200 w. Sci Am—Aug. 31, 1901. No. 42969.

India.

The Shortening of the Main Routes in India. Stafford Ransome. Concerning changes to be made on the Calcutta and Bombay route. Ill. 500 w. Engr, Lond—Aug. 16, 1901. No. 42953 A.

Interlocking.

Pneumatic Interlocking on the London and Southwestern. Diagram and locking sheet showing the scheme of a signaling plant lately put in service at Grateley, 72 miles from London. 700 w. R R Gaz—Aug. 16, 1901. No. 42679.

Interurban.

The Interurban Electric Railways of Ohio. George S. Davis. An interesting account of the rapid development of electric railways in this state, giving much information concerning the different projects. Map. 13000 w. St Ry Jour—Aug. 3, 1901. No. 42551 D.

The System of the Toledo and Monroe Railway. William S. Conant. Illustrates and describes this portion of a proposed line to connect the cities of Detroit and Toledo. 3500 w. St Ry Jour—Aug. 3, 1901. No. 42549 D.

Loop.

The Interurban Railway Loop at Columbus, O. Illustrates this loop and describes its construction. 1700 w. Munic Engng—Aug., 1901. No. 42559 C.

Railway Construction.

The Use of Concrete in Railway Structures. Editorial on the varied purposes to which concrete is now applied, either alone or in combination with steel. 3800 w. Eng News—Aug. 15, 1901. No. 42690.

Roundhouses.

Roundhouse Construction and Equipment. Editorial discussion of needed improvements and best construction. 3900 w. Eng News—Aug. 22, 1901. No. 42909.

Stations.

A London Railroad Station. Illustrated detailed description of Euston station, of the London & North Western Railway. 1900 w. R R Gaz—Aug. 2, 1901. No. 42506.

New Union Passenger Station at Dayton, O. Illustrated detailed description of an exceptionally fine station. 1400 w. Eng News—Aug. 8, 1901. No. 42601.

Proposed Union Station at Troy, N. Y. A brief account of the present condition of the property, with an illustrated description of the structure proposed. 700 w. Ry Age—Aug. 23, 1901. No. 42779.

Street Railway Stations in Basle (Strassenbahnhöfe in Basel). With views and plans of several of the attractive buildings at the stations and waiting places of the street and local railways. 1500 w. Schweizerische Bauzeitung—Aug. 17, 1901. No. 42851 B.

Station Roofs.

Railway Station Roofs. Discusses and criticizes the roofs used on stations of British railways. 2700 w. Engr, Lond—Aug. 2, 1901. No. 42648 A.

Terminals.

Terminal Improvements at Savannah. An illustrated description of the recent work by the Georgia & Alabama Terminal Company, on Hutchinson Island, opposite the city of Savannah, and on the north bank of the Savannah River. 1300 w. R R Gaz—Aug. 2, 1901. No. 42509.

Tramways.

The Naples-Aversa-Caivans Interurban Electric Railway System. An illustrated description of this line and the region through which it passes. 1200 w. St Ry Jour—Aug. 3, 1901. No. 42547 D.

The System of the Atlanta Rapid Transit Company. Illustrated detailed description. 2500 w. St Ry Jour—Aug 3, 1901. No. 42546 D.

Tunnel Ventilation.

A Proposed Ventilating System for the Park Ave. Tunnel, New York City. Albert A. Cary. Illustrated description of the system proposed by the writer in his testimony before the Grand Jury while investigating this problem. Also editorial. 2300 w. Eng News—Aug. 8, 1901. No. 42606.

Union Pacific Ry.

The Rebuilt Union Pacific. An illustrated article giving information concerning the heavy engineering work that has been carried out in the recent improvements on this road, at a cost of about $15,000,000. Map. 3300 w. Ry Age—Aug. 9, 1901. No. 42662.

TRAFFIC.

Freight.

Management of Freight Trains and Freight Houses. Abstract of a paper by L. C. Fritch. Suggestions from the Supt. of the B. & O. Southwestern. 1600 w. R R Gaz—Aug. 9, 1901. No. 42611.

The Handling of Freight Traffic. L. C. Fritch. Full paper. Discusses the classification, methods, &c., offering suggestions of value. 1600 w. St Louis Ry Club—Aug. 9, 1901. No. 42959.

Graphic Records.

Graphic Records of Cars and Trains. Notes from G. F. Richardson, master of transportation on the Southern Pacific, concerning graphic methods in use. 1500 w. R R Gaz—Aug. 16, 1901. No. 42680.

MISCELLANY.

East Indies.

Increase in Capacity of the Mountain Railways in the Dutch East Indies Verhooging van de Capaciteit van Bergspoorwegen in Nederlandsch-Indië). A. Snethlage. With map of the road between Buitenzorg and Bandong, and data of the traffic. 4000 w. De Ingenieur—Aug. 3, 1901. No. 42847 D.

EXPLANATORY NOTE.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.

Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Ingenería. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

VOL. XXII. NOVEMBER, 1901. No. 2.

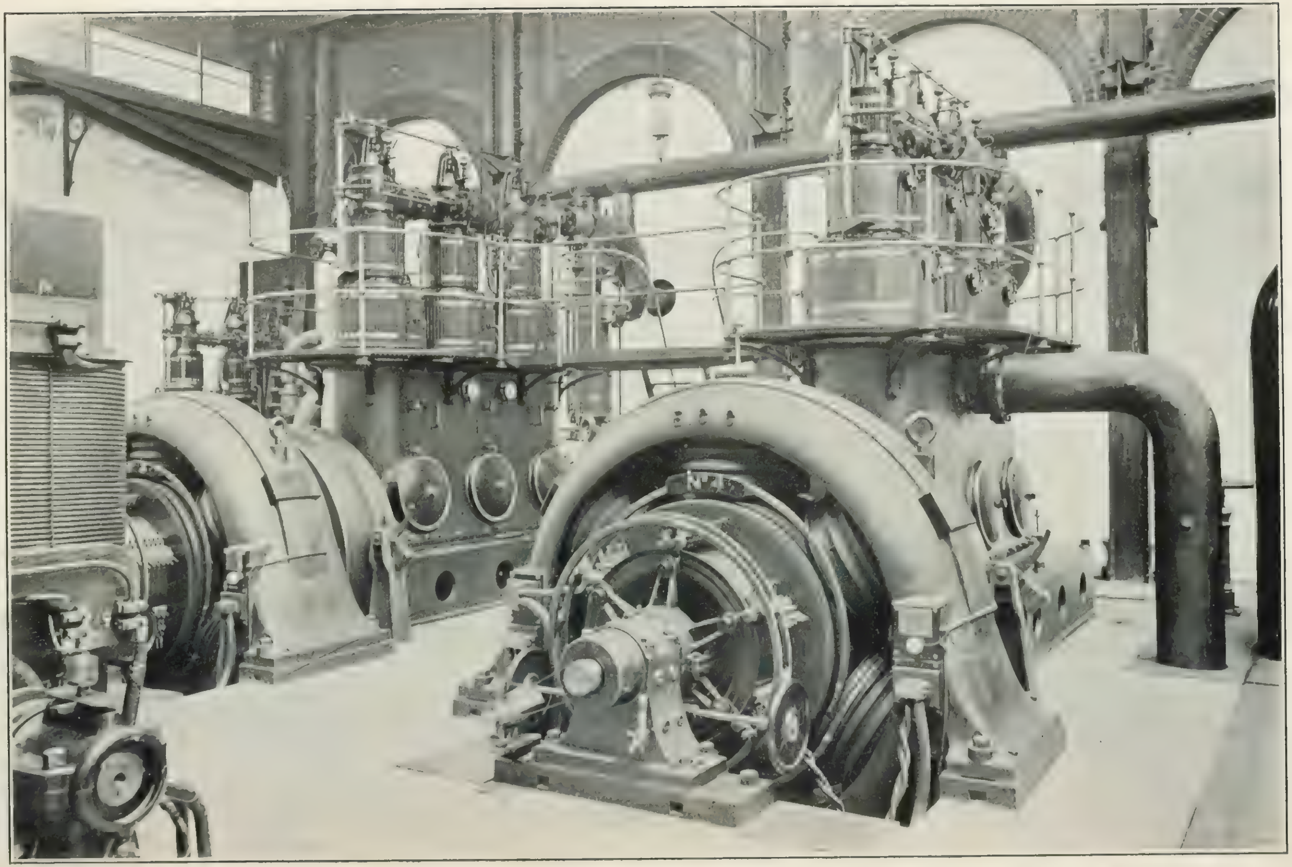
ENGLISH, AMERICAN AND CONTINENTAL STEAM ENGINEERING.

By Philip Dawson.

The most striking result of the spread of international competition in engineering work is the general betterment of practice everywhere. Reciprocity extends to the mutual interchange of that which is best, and common abandonment of that which is inferior. It is a survival of the fittest in which absolute ideals of excellence are fast superseding merely national ideals. The process is still in full progress, and those vitally interested can be best aided by clear knowledge of what is being done abroad in comparison with what is being done at home.

Steam engineering affords a field enormously exceeding all others, and in it the most directly competitive opportunities are found in the large power house. To this Mr. Dawson's articles are devoted. His friendly but fearless criticism and praise make the series, which begins in this issue and will run through four numbers of THE ENGINEERING MAGAZINE, invaluable to designers, builders, or managers of steam-engineering plants.—THE EDITORS.

AT the present time it is no longer possible to doubt the fact that engineering is not confined to any one country or language, but that it is international and knows no boundaries. Community of interests should be freely admitted and no single group of engineers or manufacturers can ever hope to excel at all points. The more it is possible to assimilate the best practice of all countries, the better it will be for the industry. An attempt will be made in these articles to call to the attention of those interested some of the merits and faults which are to be found in steam-engine practice as applied to electric-power plants in various countries. The author has had special facilities for personally investigating the work and progress both in Europe and America, and being a member of most well-known European and American engineering societies has had the



WILLANS ENGINES AT THE CITY AND SOUTH LONDON GENERATING STATION. TWO SETS OF 575 HORSE POWER EACH.

opportunity to appreciate to the full the international hospitality extended by engineers to others all over the world. The familiarity with European languages he trusts may enable him to lay before his readers some points in connection with the subject which may be both interesting and instructive.

Every engineer and manufacturer should strive to be first in his own particular sphere, and rivalry is to be commended and encouraged; but it should be free from jealousy and personal ill feeling. This is a state of affairs which is somewhat difficult of attainment, but the interchange of visits amongst the various engineering associations and the fraternal intercourse which must necessarily take place amongst engineers of all nations is doing much, and will do more, to put matters upon a friendly footing. Frank recognition of merit irrespective of origin is the true and only secret of success, and failing this, no nation, engineer, or manufacturer can ever hope to maintain the leadership.

It may be if interest here to run through briefly the leading characteristics of engineers and their methods, in Great Britain, America, and on the Continent; hereafter we will examine the three sections more minutely.

Broadly speaking the difference between the three types mentioned above is as follows:—

The average English mechanical engineer is a first class mechanic and rarely a business man or a scientist.

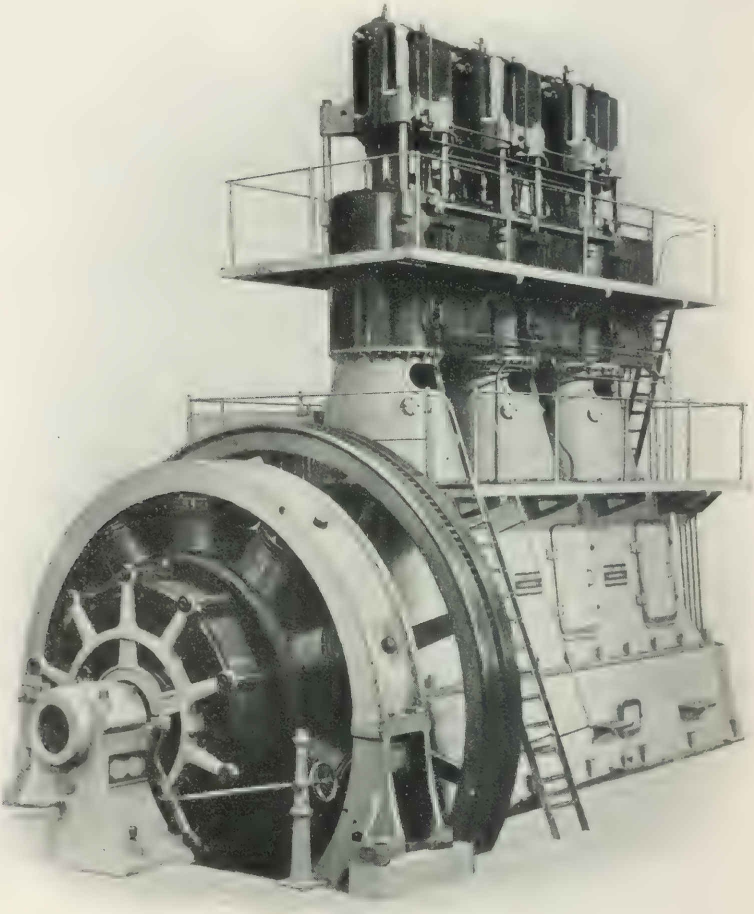
The American engineer is a scientifically trained business man.

The Continental engineer is a highly trained theoretical man.

Great Britain:—A few years ago steam-engine practice would have been classified under the same heads, but with recent years it has become much more alike in all countries.

For many years in England the high-speed high-pressure direct-coupled type was practically the only type of engine used in power stations. This was due to Willans building an engine capable of running at a sufficiently high speed to enable it to drive the then-existing dynamos direct. This type was also partly the result of marine practice, especially of torpedo-boat engines.

United States of America:—In America at the present day, slow-speed Corliss engines are the favourites. Till the World's Fair of 1893, engines were always belted to the dynamos, which were of very moderate dimensions, and liable to frequent breakdowns; hence the practice of using countershaft by which means any engine could drive any dynamo.



BROWETT & LINDLEY HIGH-SPEED 1500-HORSE-POWER SET.
One of eight for the Salford Corporation.

Continent of Europe:—On the Continent of Europe engines driving dynamos either by belts or ropes were preferred to direct coupling, because the former method enabled small cheap dynamos to be used. This is now no longer the case and slow-speed direct-coupled sets are practically universal.

Great Britain was the home of the steam engine. America originated the high-economy, small-clearance, trip-gear type; the Corliss gear, invented by George Corliss and Edwin Reynolds enables cylinder clearance to be reduced to a minimum. The Continent introduced the poppet-valve trip-gear, although this is really only another form of the

Cornish valve. The Sulzer valve was introduced by an Englishman, Mr. Brown (of Sulzer Bros., Winterthur), the father of the well-known electrician, C. E. L. Brown, who is the founder of the celebrated firm of Brown & Boveri, of Baden, Switzerland.

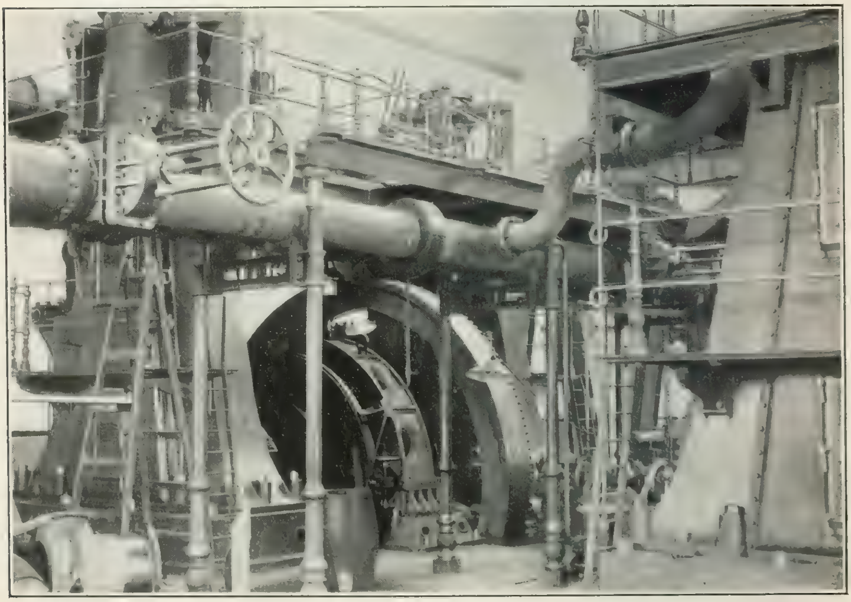
Boiler-house practice of a few years ago was, if anything, more varied still. England was using the Lancashire and Cornish types, Scotland the multitubular wet-or-dry-back marine boiler, America evolved the Babcock & Willcox water-tube boiler, while on the Continent a composite, built-up form of boiler was most common, France using the "elephant" type and Germany a combination of Cornish or Lancashire surmounted by the fire-tube type.

The advent of electric traction and power transmission has done much to internationalise electrical and steam engineering. The electric tramway, first shown by Siemens at the Berlin Electrical Exhibition of 1879 and then installed on the Berlin Lichterfelde tramways, came to England and was adopted on a practical scale by Magnus Volk at Brighton, by Holroyd Smith at Blackpool, by the late Dr. John Hopkinson at Bessbrook-Newry, and by Sir William Siemens at Portrush. Electric traction was, however, developed and brought to perfection in the United States by such concerns as the Bentley Knight, Thomson-Houston, Westinghouse, Edison, and Sprague companies; and most of our knowledge of this subject at the present day comes from the United States.

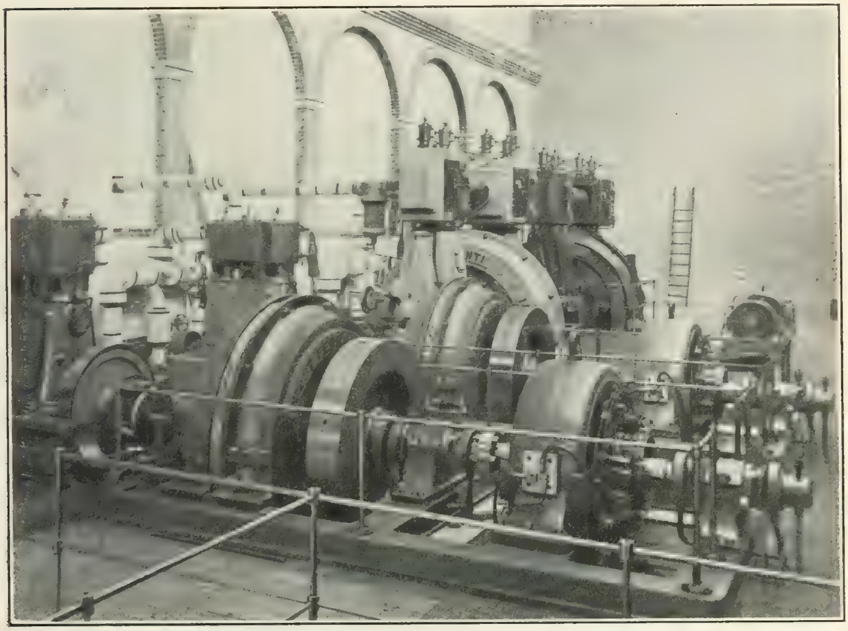
The transmission of power by means of electricity was first shown at the Vienna Exhibition, where the reversibility of the dynamo was quite accidentally discovered. The first employment of this principle on a large scale, and also the first commercially successful utilisation of polyphase currents, was shown by Von Dolivo Dobrowolski and the Allgemeine Elektricitäts Gesellschaft and Maschinenfabrik Oerlikon at the Frankfort Exhibition in 1891. This was the well known and now classical Lauffen-Frankfort power transmission. The rapid growth of electric traction and power transmission has done much to encourage and develop the construction of the steam engine and the design of large, highly economical units.

The greatest development of the electrical and allied industries has certainly taken place in the United States, which, as we have seen, although not the birth-place of the industry, has done more than any other country to develop it. Great Britain has always been known as the birth-place of the steam engine, as Thurston shows so well in his history of the steam engine. Newcomen and Watt are household words, and Willans, the inventor of the economical high-speed engine, is also well-known. The historical side of the subject does not concern us here, however, and we will proceed to examine, as closely as is practicable in the space at our disposal, the different forms of steam-engineering practice which exist in various countries, commencing with Great Britain.

The United Kingdom. Till within the last half-century England had nothing to learn or fear from any other nation; but all that has been changed now, and the sooner she realises the progress which other countries have made and are still making, the better it will be for her. The practice of dispensing with belts, ropes, countershafting and gearing, with their attendant losses and troubles, and coupling the engine direct to the dynamo, originated in England, and most of the credit for this move belongs to Willans. He it was who first built an economical high-speed engine capable of driving the small bi-polar dynamos then in use, dispensing with the necessity of belts to raise the speed, and this type of engine is still one of the most successful at the present day in Great Britain. Willans commenced by building engines for running launches on the Thames, and it is a remarkable fact that nearly all the successful high-speed-engine builders of Great Britain have been connected at some time with marine work. Up till quite recently the small direct-coupled high-speed engine and dynamo was



MUSGRAVE ENGINES AT BOLTON CORPORATION ELECTRICITY WORKS.
1,000 indicated horse power, cylinders 24 and 45 by 42 inches, 100 revolutions per minute.



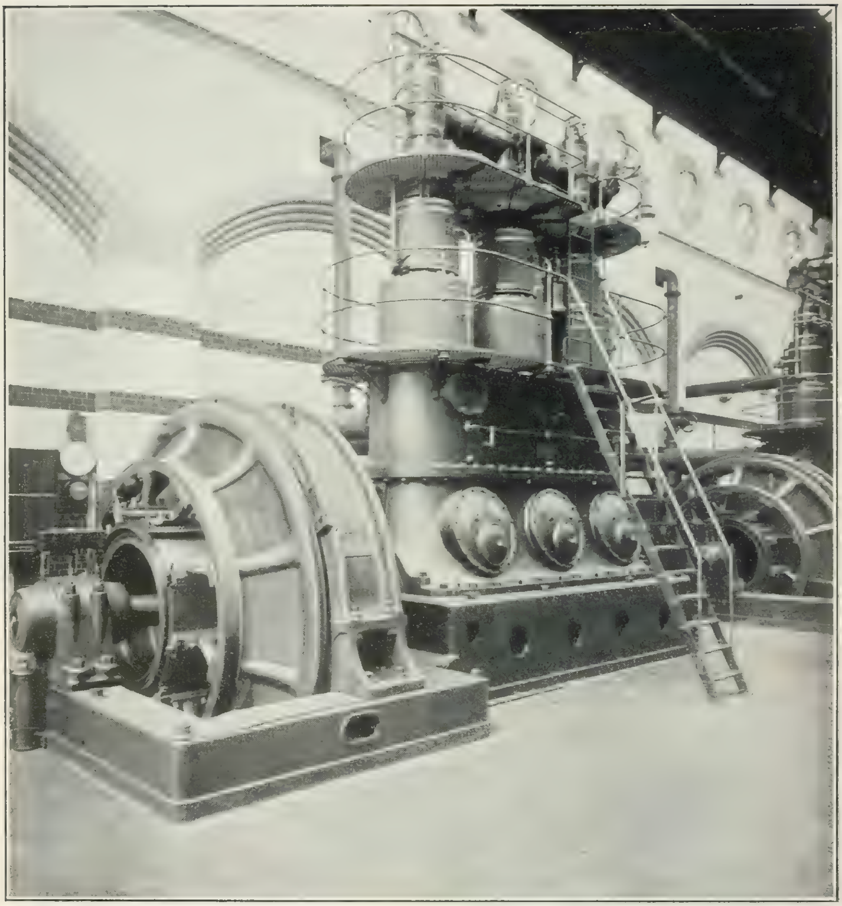
THE PLYMOUTH CORPORATION ELECTRICITY WORKS.

Ferranti engines direct-connected to Ferranti dynamos and Bellis engines direct-connected to Ferranti alternators and Westinghouse direct-current dynamos. By this arrangement the steam engines can be disconnected and the continuous-current dynamos used as motors to run the alternators from a storage battery.

standard British practice. It was also usual to employ Lancashire or Cornish boilers, with a duplicate system of steam and water mains, steel bends, and tees; Hopkinson or Dewrance valves with external screw supported on turned steel columns, and steel cross-head, were nearly universal practice.

The high-speed engines now in use can be classified in two ways, being divided into single and double-acting, or open and closed. A brief description is here given of some typical high-speed engines of British manufacture.

Willans Engine. These engines are single-acting vertical engines, and are made either simple, compound, or triple expansion. The piston rod is hollow and contains the valves, which are of the piston type, all mounted upon one rod which is operated by an eccentric mounted upon the crank-pin. The steam enters the hollow piston rod and is admitted to the first cylinder by the movement of the rod and valves, and exhausts through the piston rod into the next cylinder. In place of the ordinary cross-head and guides, there is a guide piston; on the up stroke of the engine, air is compressed in the space above this piston

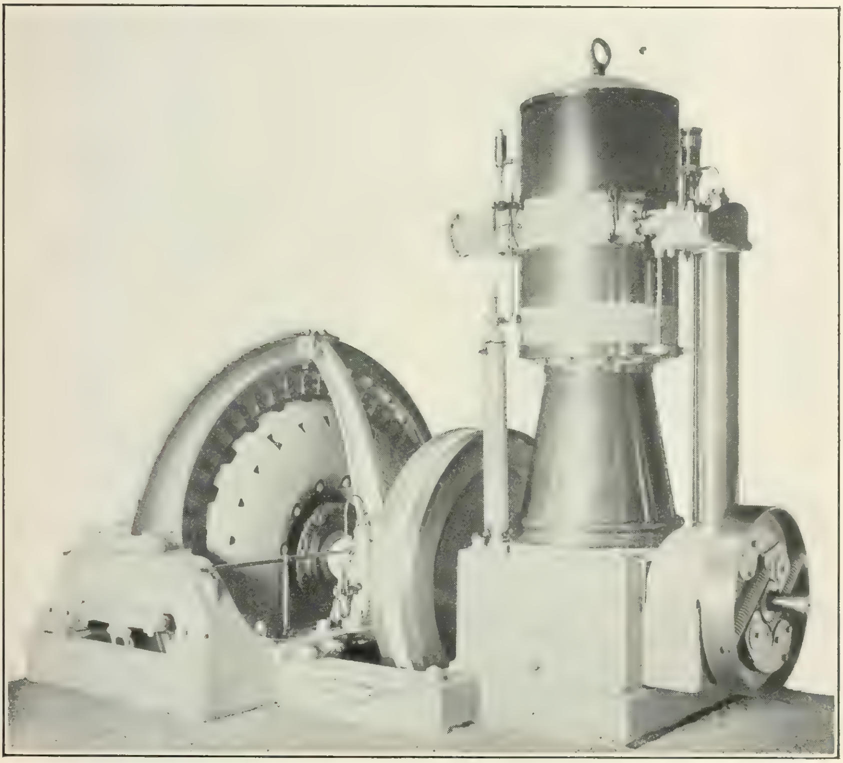


WILLANS ENGINE AND SIEMENS DYNAMO, PUMPFIELDS STATION, LIVERPOOL.
Nine-cylinder triple-expansion, 230 revolutions per minute; cylinders 15, 20½, and 34⅝ inches by 18⅔ inches stroke. Shunt-wound, self-excited dynamo of 1,420 amperes at 550 volts.

and the bottom of the low-pressure cylinder, and thus the pressure in the bearings is never reversed. The great advantage of this is that it ensures complete absence of knock and thus reduces wear to a minimum. The work done in compressing the air on the return stroke is nearly all given out again in the next working stroke, so there is practically no loss. The speed is controlled by a shaft governor operating a throttle valve. All the working parts are completely enclosed.

One great disadvantage of single-acting engines is that for a given power they must have twice the cylinder capacity of a double-acting engine, or must revolve twice as fast, if the cylinder capacity is the same.

The Universal Engine. This engine, designed by Mr. J. S. Raworth, is also of the vertical high-speed single-acting enclosed type, but differs considerably from the Willans. The cylinders are arranged tandem, and the distribution of steam is effected by two Corliss valves placed between the cylinders, by which means clearance is reduced to a minimum. By a special arrangement, the high-pressure cylinder is jacketted inside and outside with steam at the pressure of the receiver, which encloses it. The valves are actuated by ordinary eccentrics, one of which is controlled by a shaft governor.



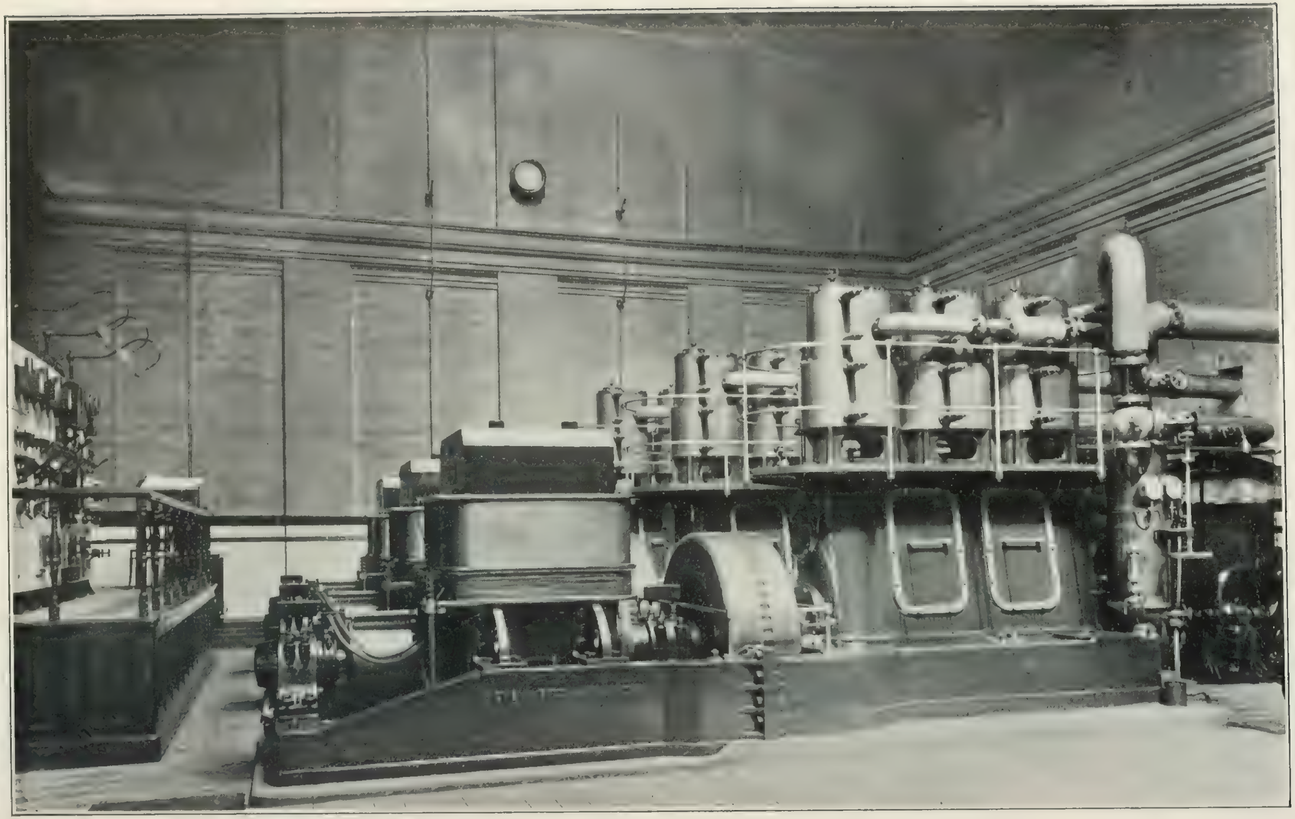
RAWORTH SINGLE-ACTING ENGINE CONNECTED TO BRUSH ALTERNATOR.

Some of the advantages claimed by the makers for the Universal engine are given below.

1. The short steam ports and single-acting cylinders render it highly economical.

2. The working parts are very few in number.

3. The wearing parts are extremely easy of adjustment; the peculiar construction of the connecting rod enables the cross-head and



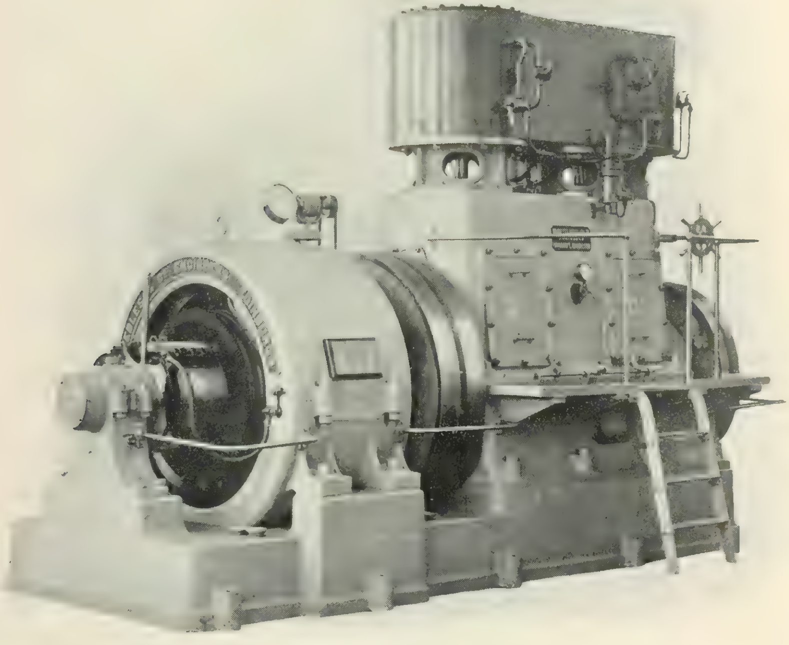
ENGINE INSTALLATION OF THE HULL ELECTRIC TRAMWAYS CORPORATION.

Three Bellis engines of 476 indicated horse power, 360 revolutions, coupled to Siemens bi-polar dynamos of 500 amperes and 500 to 550 volts. Each engine has three cranks, and three sets of two cylinders arranged tandem.

crank-pin brasses to be adjusted at one operation, and with great ease.

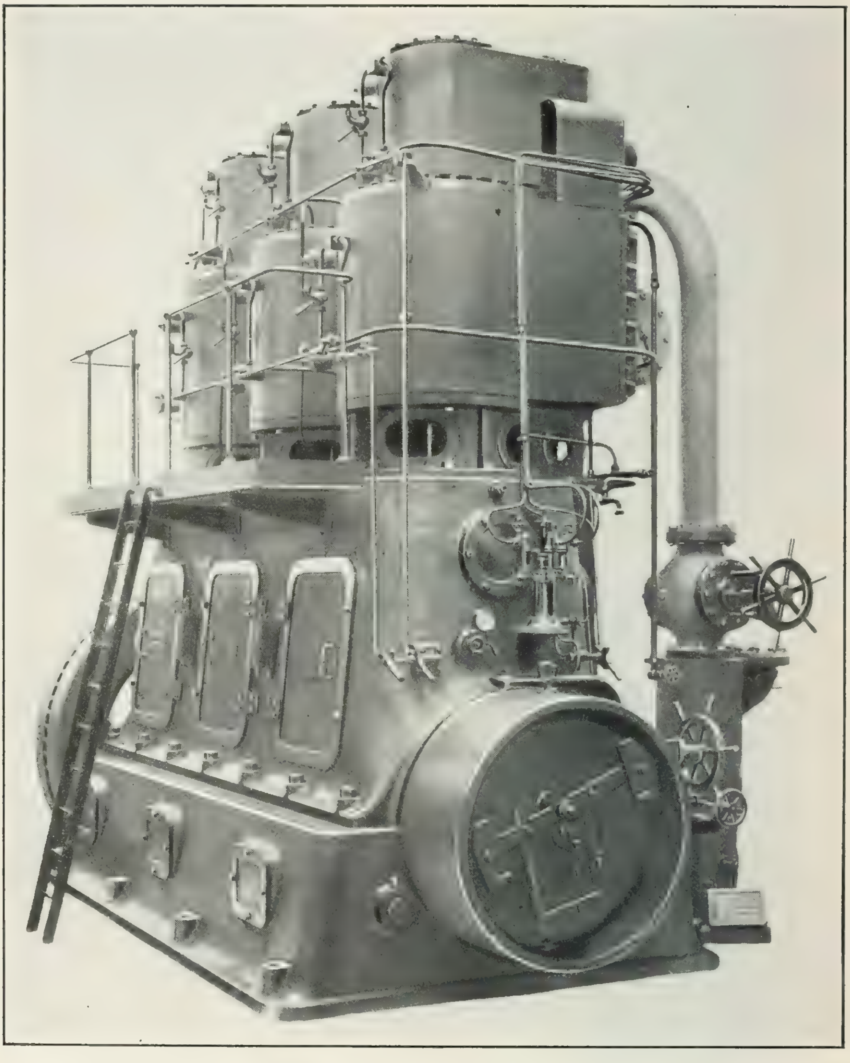
4. By virtue of its construction it is naturally self-draining.
5. The single-crank engine gives two impulses per revolution.

The engine is made with both single and double cranks. The former type ranges in size from 28 indicated horse power, 500 revolutions per minute, and a 5-inch stroke, to 500 indicated horse power, 212 revolutions per minute, and a stroke of 17 inches. The double-crank type is manufactured in sizes ranging from 250 indicated horse power, running at 340 revolutions per minute with a 9-inch stroke, up to 1,000 indicated horse power, running at 212 revolutions per minute and with a 17-inch stroke.



BROWETT & LINDLEY HIGH-SPEED 150-KILOWATT ELECTRIC-TRACTION SET.
For Maybank Station, North Stafford Trams.

Bellis Engine. The Bellis engine is double-acting, and, by the aid of forced lubrication, has all the advantages of quiet running at high rotative speeds which is possessed by the single-acting engine, with the additional advantage of obtaining extra power for the same cylinder capacity. Although this engine is termed a "high-speed" engine, the piston speed is quite low. The forced lubrication supplies oil to



BROWETT & LINDLEY HIGH-SPEED 1500-HORSE-POWER ENGINE.
For the Liverpool Overhead Railway.

the bearings under a pressure of about 15 pounds per square inch, by means of a simple pump without valves or packing. This pump is worked off the valve eccentric. The two cylinders are side-by-side, with the valves (which are of the piston type) between them. The cranks are set opposite each other, and all of the working parts are enclosed. The cross-head guides are cylindrical and are cast in one with the cylinders.

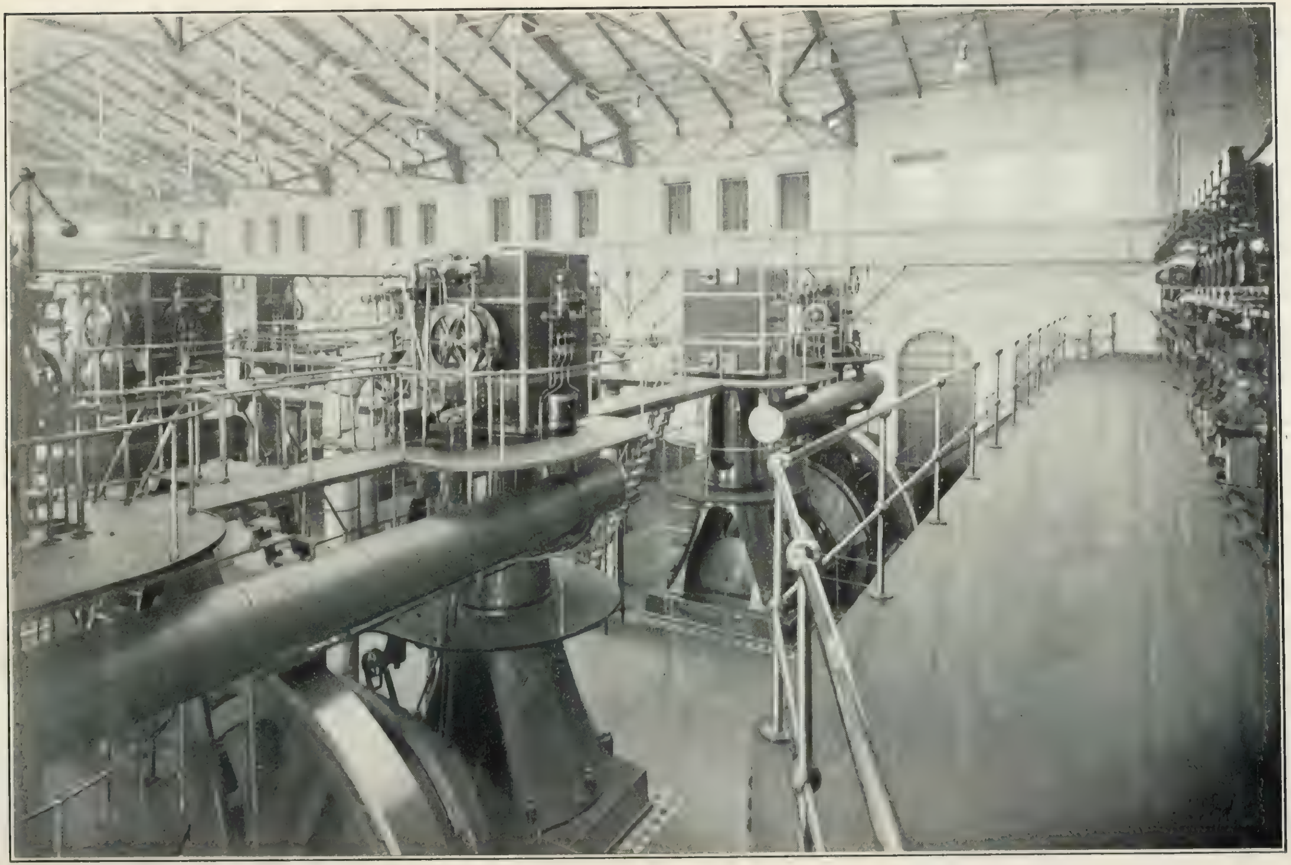
Messrs. Browett, Lindley & Co., Ltd., also make high-speed engines, of the double-acting type, with forced lubrication. The oil is supplied to the bearings under a pressure of about 15 pounds per square inch by means of a small valveless pump. These engines are built in various styles, the most usual being the vertical enclosed type, with two or three cranks. At the Oldham, Ashton, and Hyde traction power-plant there are three of these engines. They are of 650 horse power each, with two cranks, the cylinders measuring 16½ inches and 31 inches by 17 inches stroke. Each engine is equipped with Westinghouse and Rites patent central valve; there are two flywheels, one between the engine and dynamo, 8 feet in diameter and weighing 3 tons, and the other on the outside end of the engine. The latter contains the governor, which is of the Begtrup automatic flywheel type, acting on both cylinders, and controlled by a sliding weight; the speed can be changed from 190 revolutions per minute to 210 revolutions per minute. Forced lubrication is supplied by two sets of oil pumps to each engine, one pump being held in reserve. Each engine is provided with a steam separator, blow-through valves for warming up the cylinders, and water circulation round the slides. The dynamos are of the two-pole type, made by P. R. Jackson & Co., Ltd., and are three in number. Each dynamo is direct-coupled to one of the engines, and has an output of 550 amperes at 550 volts when running at 210 revolutions per minute for traction work, and of 680 amperes at 400 volts for lighting. Messrs. Browett, Lindley & Co. have recently supplied engines of 1,500 horse power for the Liverpool Overhead Railway and Salford Corporation.

The following remarks and suggestions embody all the best points in the present-day English practice in this branch.

The steam valves, high- and low-pressure, should be separate. It is only in one or two makes of the very highest class that single valves between the two cylinders can be kept from passing steam direct from the high-pressure steam space to the low-pressure exhaust. If this does not happen when the valves are new, it frequently develops after running some time, unless the valve packing rings are of a perfectly adjustable type.

The crank pit should be formed into a receptacle for the oil dropping from the working parts, which latter should be completely enclosed, doors being arranged that can be readily opened when required.

A small oil pump should be arranged to work from the crank shaft or eccentric sheave and draw its supply of oil from the crank-pit chamber, a suitable straining device being interposed. This pump should



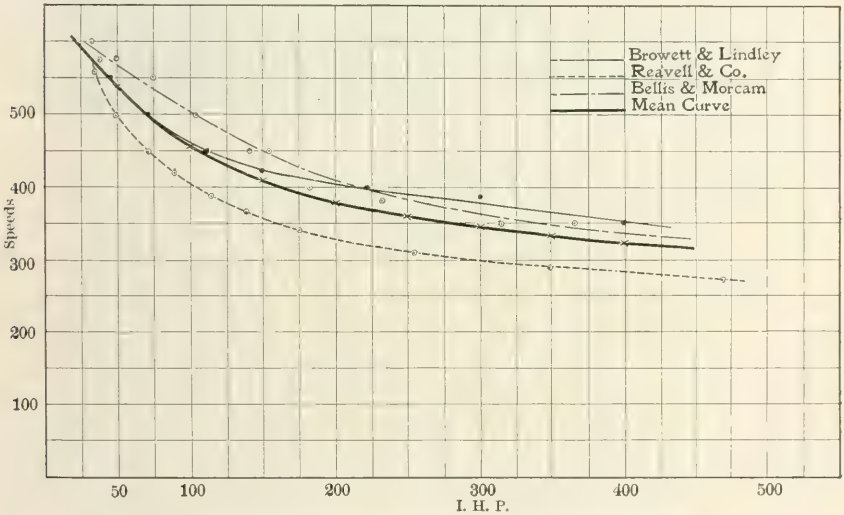
AN ANGLO-AMERICAN INSTALLATION. ALLIS ENGINES AT RINGSEND STATION, DUBLIN UNITED TRAMWAYS.

Six engines, 20 and 40 inches by 42 inches stroke, 800 horse power, vertical cross-compound condensing.

deliver the oil under pressure to the three main bearings and both ends of connecting rods, also to the high- and low-pressure eccentric straps, the pressure required being about 20 pounds.

The cranks should preferably be opposite to one another and do not require to be fitted with balance weights. It is desirable to have oil-throwing rings fitted on the crank shaft, so as to prevent oil travelling on to the dynamo armature.

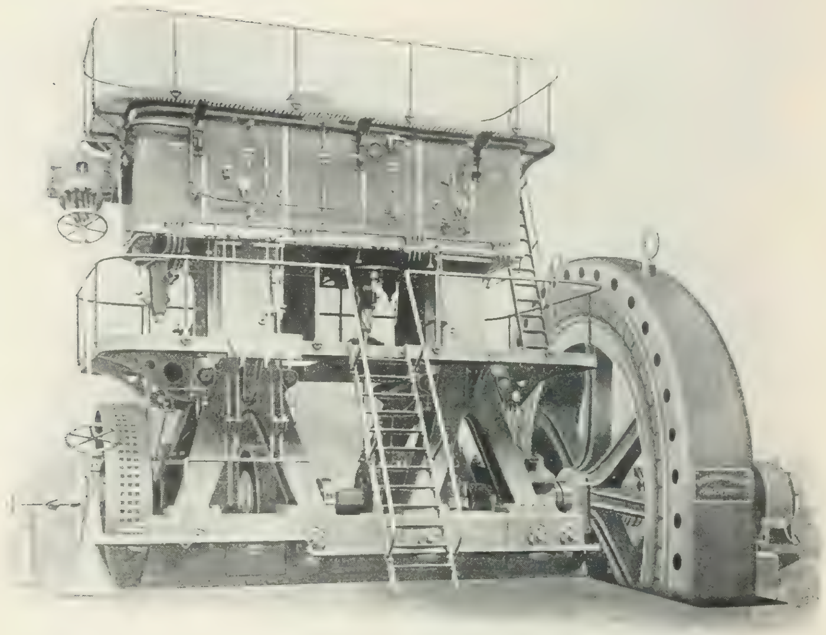
It is found that the regulation and steam economy with high-speed vertical compound engines is quite as good with the throttling type of governor as with the variable-expansion shaft governor. The throttle valve, however, should be most carefully designed, and preferably be of the equilibrium type actuated directly from the crank shaft. A device should be fitted to provide for adjustments while the engine is running. A vertical steam separator should form part of the engine and stand on the same bed.



Revolutions and Power of Some British High Speed Engines.

A small fly-wheel should be provided, preferably with holes bored radially in the rim to permit of barring the engine round when necessary. The engine cylinders should stand above the main casing of the engine, hand holes being provided in the distance pieces so that the glands may be easily accessible. It is preferable to have these packed with metallic packing, especially in the case of the high-pressure cylinder. The type of connecting rod universally adopted for high-speed work in Great Britain is of the marine pattern.

The engine should preferably stand upon a deep section bed, so that



WESTINGHOUSE STEAM ENGINE DIRECT-CONNECTED TO WESTINGHOUSE 2500-HORSE-POWER ENGINE-TYPE GENERATOR.

Metropolitan Electric Supply Co., Ltd., Willesden. Cylinders 35 and 55 inches by 36 inches stroke, 116 revolutions per minute.

the dynamo bed-plate may be bolted directly to it and all rest upon a level foundation, the joint between engine and dynamo beds being made flanged with heavy fitted bolts.

In the larger-sized engines it is preferable to drive each crank by an independent tandem-compound engine, with one throttle valve to control the supply of steam to both high-pressure cylinders, rather than to use one high- and one low-pressure side-by-side. The cross-head guides should be of the bored type and form part of the casting which closes on the top of main casing and supports the cylinders. If adjustment is provided, it should be of the wedge type with all bolts and nuts securely locked to prevent any possibility of these coming adrift in working. Attention should also be given to the position of adjusting screws so that these may be easily "get-atable." Hand holes are frequently fitted to the ends of the engine casing, about the height of centre of slides in two-cylinder engines, for this particular purpose.

The following paper will be devoted to brief description of some of the most important British electric-lighting and traction plants.

THE STANDARDIZATION OF ELECTRICAL APPARATUS.

By J. T. Broderick.

In this article Mr. Broderick supplies the complement to his preceding paper in our October issue setting forth the argument for standardization from the manufacturer's view-point. The key-note of both is the same—economy of energy in the interest of increased and cheapened production. It is a proposition in complete accord with modern industrial evolution, and Mr. Broderick states it clearly, concisely, and convincingly.—THE EDITORS.

A PRECEDING article on the standardisation of electrical apparatus, in THE ENGINEERING MAGAZINE for October, is devoted mainly to a consideration of the questions of cost, delivery, and quality, and of the bearing which these questions have upon the interests of the manufacturer. The object of the present paper is to show, in a general way, how standardization affects the interests of the consumer; the term consumer being used here to denote all classes concerned with electrical apparatus after it leaves the factory.

As costs most directly touch the pocket-book of the manufacturer, so the prices fixed by the manufacturer for his finished product most directly touch the pocket-book of the consumer. The reductions in the prices of electrical apparatus during the past ten years have ranged from 25 per cent. in some instances to 75 per cent. in others. While the influence of competition may to some extent be reflected in these reductions—which may be said to be enormous for so comparatively brief a period—that influence has not been so potent as one at first thought might infer. Competition has sometimes been symbolized as a hammer forcing prices down; but, for reasons which need not be discussed at length here, it is evident that it also tends to keep prices up. Prices, in the electrical or any other industry, cannot be forced below the level of costs without bringing about general demoralization and, for some, financial ruin. It is necessary to go deeper than competition, which, at the most, is only locally and transiently effective, to account for the result indicated. Prices have been lowered in a great measure because of progress made in simplification and economy of design, of improvements in methods of manufacture, and of increased efficiency of labor. The progress on the score of design has resulted from the concentration of engineering effort on types and sizes standardized either by selection based on anticipated requirements or by the process of natural selection; and the improvements in methods of manufacture, with the increased efficiency of labor, have, in turn, been rendered possible only because these types and sizes—gradually improved in design—have been built in ever increasing quantities. Any reduction in prices effected by such means as these never suggests the unpleasant idea of loss to someone; it is beneficial to the consumer, and at least not injurious to either the manufacturer or his workmen.

The importance to the consumer of the prompt fulfilment of promises of delivery will be at once acknowledged. Time is one of the principal elements in every business calculation. Failure to start a street railway or the machinery of a mine or mill at an appointed date, because of delay in the installation of the electrical equipment, occasions great inconvenience where it does not entail serious loss. As apparatus of standard types and sizes is kept in stock, it may always be ordered with the assurance that it can be delivered when needed. Special apparatus must be built to order, and, as stated in substance in the previous article, while the manufacturer is usually able to estimate the period within which it can be produced, his estimate, however conservative, may be exceeded because of extra time consumed in carefully working out the new features of design called for, of minor changes in the specifications found necessary after the order has been placed, of contingencies in the manufacturing stage, and of unexpected delays in securing raw material. The time consumed in the work of installation is also less with standard than with special apparatus, inasmuch as information relative to the adaptation of engines and foundations is more available.

Of quite as much moment to the consumer as the assurance of a reasonably low initial outlay and prompt delivery is the assurance that his apparatus will operate satisfactorily after it has been installed. A standard machine suggests no uncertainty so far as satisfactory operation is concerned. The mere fact that it *is* standard—provided, of course, it be the product of a reputable manufacturer—constitutes as strong a guarantee on the score of operation as any formal one that could be given. It is built under the most favorable conditions, its construction embodies the best features of electrical and mechanical design, and its prototypes have been tested in actual service. It represents problems solved, difficulties encountered and overcome; it is an evolution—the outgrowth of experience, the crystallization of the ideas of many alert and painstaking workers. A special generator or motor, by reason of its being the first of its kind built, is in some respects an experimental machine. The utmost care may be exercised and the latest available data be applied in its design and construction, and it may pass a rigid inspection and fulfil specified requirements under test. But in spite of all this, the fact remains that it is a new development; and in the nature of the case it stands at a disadvantage as compared with a machine which is the result of years of effort and of which many duplicates are already performing satisfactory service —it cannot be installed with the same assurance that no feature of design or construction essential for perfect operation will be found lacking.

It will be observed that prices, deliveries, and operation in service have thus far been considered with reference only to their bearing on an original installation. A study of standardization from the viewpoint of the consumer would be very incomplete if it failed to touch upon the feature of interchangeability. The question of maintenance, if anything, is more important than that of the initial investment; one is always present while the other is settled when the conditions of the contract with the manufacturer are fulfilled. Renewal parts for a standard machine are less expensive than similar parts for a special machine, because their manufacturing cost is lower and because less skill is required to put them in place; the likelihood of securing them promptly is greater, because they are more likely to be kept in stock; they may be ordered with more assurance that they will prove satisfactory, for the simple reason that they are for a standard machine whose characteristics and properties are more familiar to the factory engineers and mechanics than are those of a special machine. The longer a special machine has been in service, of course, the more perplexing the problem of making repairs is likely to be. If its construction happens to embody features departing radically from the lines on which progress has been made—the lines of evolution—important renewal parts may be as expensive as a complete standard machine of modern construction, for the reason that the drawings and patterns of the old special machine, as well as the peculiar devices used in its manufacture, may have been destroyed or lost.

No attempt has been made in the foregoing paragraphs to be specific, although the facts presented may be readily applied to individual cases by those who have had experience in purchasing and installing electrical apparatus. A certain amount of generalization has been deemed necessary in order to establish a point of view from which the buyer and the maker may perceive how identical, in the long run, are their interests and how essential, on their part, is complete and hearty co-operation. The need ot explicit suggestions, in dealing with a subject so broad as standardization, is fully realized.

The apparatus which the manufacturer considers standard and which, therefore, is built in large quantities and carried in stock, is usually shown in his catalogues and price lists. As already indicated, this apparatus costs less than unlisted or special apparatus; it can be furnished in shorter time, and it is more likely to prove satisfactory in operation. A greater amount of thought has been bestowed upon its design than it is practicable to give—assuming the fulfilment of reasonable dates of delivery—to any new designs that may be specified. The buyer, therefore, while incidentally best serving the interests of the manufacturer, can at the same time best serve his own interests by consulting the publications referred to and making his selections therefrom whenever his requirements are such as to render this course permissible. He will sometimes find it to his advantage even to go out of his way in an endeavor to make standardized apparatus answer his requirements when it does not seem to be exactly suitable.

When the purchaser is in doubt as to the apparatus best suited to his requirements, consultation with the manufacturer cannot fail to prove beneficial. This aspect of the subject is dealt with in a clear and interesting manner in the following paragraph quoted from a paper read before the New York Electrical Society, Jan. 12, 1898, by the late S. Dana Greene:

> "The manufacturers of apparatus and the manufacturers of current are dependent upon each other to a large extent, and their relations should be close and friendly. The consulting engineer, as in other engineering trades, is a necessary and proper connecting link between the two, and I can say frankly that I believe he has a proper and permanent field of usefulness. Broadly speaking, his function is to see that his client who buys apparatus and installs it selects first that system best suited to his particular local conditions, and then, in purchasing, secures the best (not necessarily the most,) for his money. It is equally the duty of the consulting engineer to learn what the manufacturer can reasonably be called upon to make, to consult with him freely, and to obtain the benefit of his experience; to give him credit for work well-done, and to insist that bad work shall be promptly corrected. Many consulting engineers, especially those who have recently commenced practice, seem to think that it is improper to consult with the manufacturer,

or to examine his plant, or to ask him for information or advice. Their idea seems to be that, by so doing, they may be accused of partiality or undue bias, or with lack of proper care for the interests of the purchaser; or they may feel that it is derogatory to their own dignity as independent engineers. The inevitable result is that specifications often contain provisions which are a source of annoyance and expense to the manufacturer and purchaser alike, and which have no compensating advantages, from either the engineering or commercial standpoint. In fact, some of these provisions are impossible or impracticable of fulfilment; and in such cases the honest manufacturer who wishes to meet the specifications and guarantees required, finds himself forced to ask the engineer or the purchaser (sometimes both) to modify them. This is a proceeding which is always difficult and delicate to undertake, and often results in friction and trouble for all concerned. I am satisfied that if every consulting engineer would take advantage of opportunities as they occur, to visit manufacturing establishments, to see the work there in progress and to confer with the engineers, he would find himself well repaid for the visit, and his own work and practice benefitted thereby. I am equally satisfied that no reputable manufacturing establishment would refuse admittance, but on the contrary would welcome such visits as beneficial to all parties. The day of mysterious methods of manufacture, carried on behind closed doors, is past in the electrical business, and I appeal with confidence for an endorsement of the opinions just expressed to those consulting engineers who have already tried the plan suggested. I have said that I thought the engineer would find himself repaid by such visits. I think, also, that he will find himself in a better position to advise his client intelligently. A purchaser usually knows little or nothing of the relative technical merits of apparatus, and his final decision is governed largely by price and by paper statements and guarantees, which may mean much or little. The consulting engineer who has seen the apparatus in process of manufacture can advise not only as to whether the various bids comply with the specifications, but also what make or makes of apparatus are, from their design, construction, and factory inspection and test, most likely to give the least trouble and expense in continuous service."

The engineering societies have not overlooked the importance of standardization. The subject has been given much consideration by some of them, notably the American Institute of Electrical Engineers —whose work is briefly referred to in the article previously published —and the American Society of Mechanical Engineers.

The potentials and frequencies standardized by the American Institute of Electrical Engineers may not be familiar to users of electrical apparatus generally, so they are given below:

For direct-current low-tension generators, terminal voltages 125, 250, and 550.

For direct-current and alternating-current low-pressure circuits, terminal voltages 110 and 220.

For direct-current power circuits for railway and other service, voltage 500.

For alternating-current high-pressure circuits, voltages at the receiving end 1,000, 2,000, 3,000, 6,000, 10,000, 15,000, and 20,000.

For alternating-current high-pressure generators, or generating systems, terminal voltages 1,150, 2,300, and 3,450.

A maximum drop in transmission of 15 per cent. of the pressures at the receiving end is allowed in the voltages specified for high-pressure alternating currents.

For alternating-current circuits, frequencies 25 or 30, 40, 60, and 120.

These pressures and frequencies, as far as I am aware, do not correspond in all cases with those which are regarded as standard by any one of the leading manufacturers. They are given here because they comprise the latest recommendations of an impartial scientific body. It is quite likely that the Institute, in its deliberations, had in mind the pressures and periodicities in general use and that it adopted those on which is was possible to secure unanimous agreement. Moreover, a reconsideration of the subject, at the present time, might show the desirability of some modifications and additions.

The Institute, in also carefully explaining and defining such conditions of output as efficiency, rise of temperature, and regulation, has materially aided standardization. It has established a basis from which all manufacturers and engineers may work, and at the same time provided the users of electrical apparatus with accurate and authoritative information on points that in the past have given rise to much confusion, misunderstanding, and friction.

The American Society of Mechanical Engineers saw the necessity, as far back as 1899, of the fullest possible co-operation, on the part of engine and dynamo builders, as to the design and construction of direct-connected sets. These sets constituted a relatively new and at the same time a most important unit brought into the industrial field by the development of the electrical art. Numerous delays and much duplication of effort, arising from a lack of touch between the two classes of builders mentioned, had occasioned both of them a large amount of expense in the aggregate. The American Society of Mechanical Engineers, impressed with this fact, determined to do what it could, in an impartial manner, to bring about an understanding between the different builders with respect to the number and sizes of units suitable for standardization, as well as with respect to speeds, sizes of armature bores, and other features which had given rise to misunderstanding. As a result of its labors, carried on during the past two years, a list of standards is now about to be adopted with the concurrence of the principal builders of steam engines, dynamos, and electrical machinery throughout the United States.

Every manufacturer, in striving to secure the greatest economy in production compatible with high-grade apparatus and prompt deliveries, is naturally forced to give continuous thought on his own account to the standardization of mechanical details, such as shapes and diameters of nuts, screws, and bolts, forms of brush-holders, character of insulating materials and methods of applying the same, and styles of windings. Progress in these details on approximately uniform lines is perfectly feasible wherever features not distinctive and novel enough to be patentable are involved, and in a large sense it must be advantageous to the different manufacturers. The buyer in turn may become a potent factor in such progress with marked benefit to himself by taking the stand—surely a rational one—that the results of experience are likely to be the best and, on principle, avoiding special combinations.

Although, while speaking of the effect of specialization on prices, deliveries, and operation in service, complete new designs have for the most part been contemplated, needless minor variations should not be ignored. The manufacturer, naturally deeming it his duty to be as obliging as possible, is often powerless to resist these variations, which have increased during the past few years at a prodigious rate. Their proper limitation rests largely with the buyer. The arc lamp may be cited to illustrate in a simple manner the point referred to. It would be tedious to enumerate the number of possible variations—as regards finish, method of adjustment, size of carbon, and so on—in this well-known device. Such variations, sufficient in number to cover a wide range of requirements, are of course standard; but any marked increase beyond these, demanded by local companies, industrial managers, and merchants, must clog production, render readjustments in the factory necessary, delay improvements on right lines, and prevent reductions in cost.

It is recognized that progress in standardization is limited by the same conditions that limit any kind of economic progress. Old plants and systems of electrical distribution, representing large investments, cannot be discarded without individual sacrifice, and the continued production of superseded or obsolete apparatus and appliances is therefore rendered necessary. As a result, the benefits which should flow from improvements in design are in some cases neutralized by the increased cost of manufacture due to the multiplication of units required. The history of the alternating current, commercially, affords a striking illustration of this conflict between private interests and general economic progress. The alternating-current and direct-current systems have always had distinct fields of usefulness; but, with the introduction of the alternating-current system, it was seen that, for some purposes, it was more economical than the older system. It was scarcely to be expected, however, that existing direct-current plants would be abandoned. The direct-current system continued to be used in some cases where it was relatively uneconomical, and the alternating-current system was employed, where it was seen to be superior, for new installations. The effect of all this was to increase artificially the number of variations to be dealt with by the manufacturer. It may be observed, incidentally, that the economical retention of old direct-current plants and the use of the alternating-current system where it is most suitable for new installations have been permitted by means of the rotary converter, a type of machine for changing direct into alternating current or alternating into direct current.

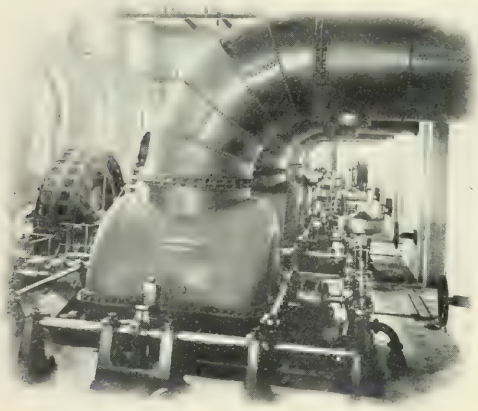
As already stated, where existing installations appear to require obsolete or special apparatus, consultation with the manufacturer is likely to prove of value. It may be found possible in some cases to use standard apparatus, without any temporary sacrifices and, of course, with immediate and future advantage; and in other cases some temporary sacrifice, involved in the adaptation of standard apparatus to requirements, may be shown to be much more than offset by the advantages accruing therefrom. In any event, nothing can be lost and much may be gained by close contact and hearty co-operation between the buyer and the manufacturer. The interests of the two are in no sense antagonistic; in a large sense they are identical.

Standardization has been represented in this discussion as both a voluntary movement and an economic necessity. Regarded as a movement, its purpose may be said to be to reduce the ratio of cost to results secured; it is therefore in complete harmony with the present tendencies throughout the industrial world. It means neither retrogression nor stagnation; on the contrary, it implies progress—progress without unnecessary expense. Because an art is advanced with duplication of effort it scarcely follows that it cannot be advanced with concentration of effort. It seems logical to assume that the greater the concentration of effort, on correct and approved lines, the more rapid progress is likely to be. Needless expenditure of energy is as wasteful in industry as war is in a nation.

GREAT ELECTRIC-POWER INSTALLATIONS OF ITALY.

By Enrico Bignami.

Our readers will recall Signor Bignami's article in our August issue describing the great 15,000-horse-power plant at Paderno d'Adda. This account of a second and larger hydro-electric installation in Lombardy will serve to show yet more clearly the wonderful industrial development which northern Italy is undergoing through the co-operative efforts of the civil, the mechanical, and the electrical engineer.—THE EDITORS.



THE water-power and electric installation at Vizzola-Ticino, Lombardy, which was commenced in 1897 and finished in less than three years, is now in full operation. Its ownership is vested in the Società Lombarda per Distribuzione di Energia Elettrica, a company having its offices in Milan and incorporated with a capital of 10,000,000 francs especially for this undertaking, under the initiative of a great foreign concern, the Continental Gesellschaft für Elektrische Unternehmungen, of Nürnberg.

At present 19,000 horse-power is developed (later there will be a development of 24,000) from the Tessin river between its source in Lake Maggiore and its debouchement into the River Po, a reach along which it feeds the marvelous network of canals, in great part a heritage of past generations, that forms the main source of the agricultural wealth of the region surrounding Milan, Novara and Pavia.

The Water-Power Installation. Taking from the forebay of the Villoresi Canal (Figure 1) 55 cubic metres of water per second of the 65 of outflow from the Naviglio Grande (which are two of the most important canals of the network) admitting this water by regulating gates into a navigable canal built near and parallel with the Villoresi canal, and conducting it to a point below the village of Vizzola, there

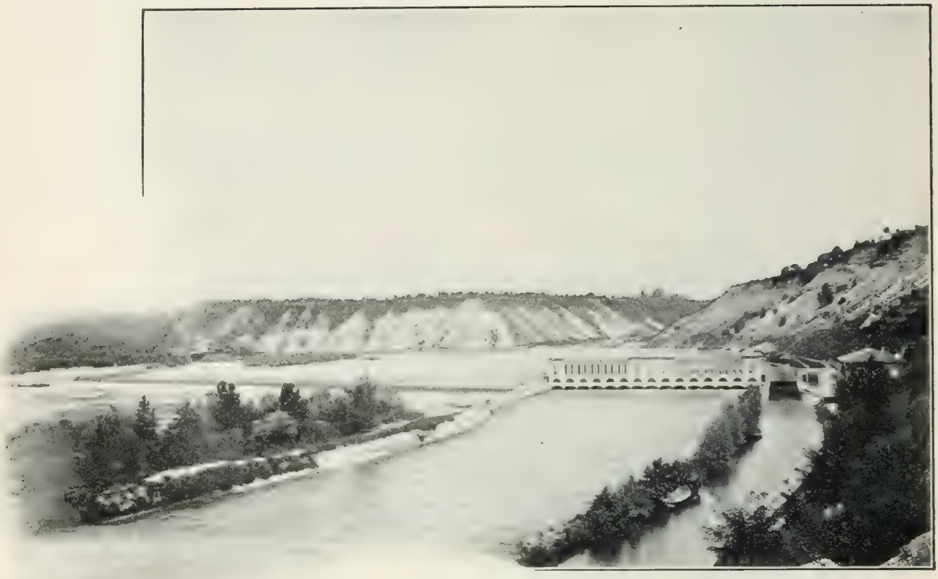


FIG. I. THE GREAT BASIN AND HEAD-GATES OF THE VILLORESI CANAL.

returning it to the Tessin river and utilising a fall of 28 metres (92 feet)—this is how the hydraulic part of the project was accomplished by the Società Italiana per le Condotte d'Acqua, a concern with offices at Rome. The general plan of the water-power development is shown in Figure 2. The normal output is based on a flow of 55 cubic metres per second (62 in floods) from a water level 165 metres above sea-level. This is taken into the new canal through a regulator having four controlling gates. The new canal has a gradient of 15 centimetres in 1,000 metres (9 inches to the mile) for 6 kilometres (3.72 miles) to the opening of the great Castelnovate cut (Figure 3, page 188). At this point it divides into two branches, of which one is exclusively for navigation, with a small flow of 3 cubic metres per second, sufficing for boat service (Figures 4 and 5), and going directly to the Tessin; the other branch turns to the left and, passing over a valley by a fine aqueduct (Figures 6 and 7) 200 metres (656 feet) long, delivers to the forebay for the turbines about 53 cubic metres per second of water available for motive power.

From the forebay the water descends in twelve separate steel penstocks, open to view, to the turbines. From these it is discharged by separate tail races into a collecting canal which, a short distance below,

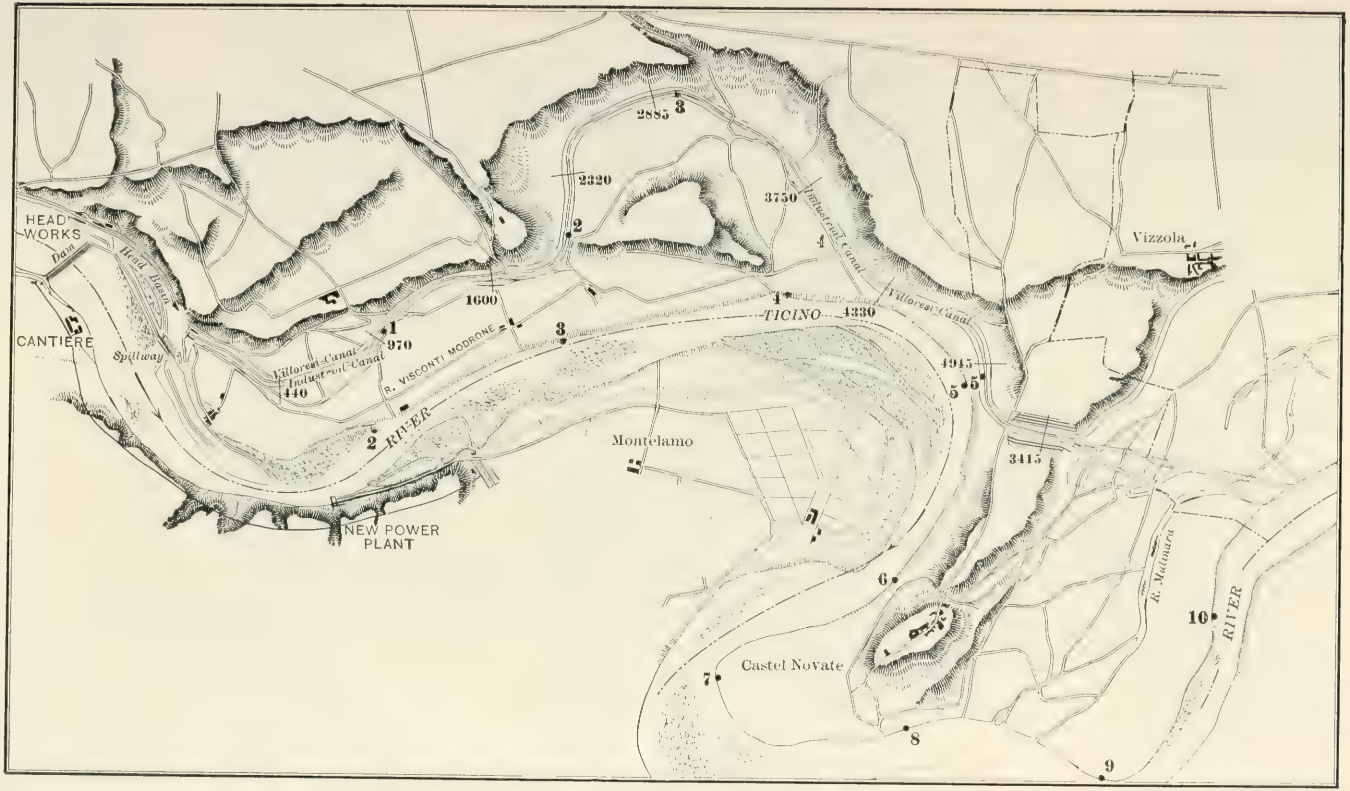


FIG 2. GENERAL PLAN OF THE CANAL AND ITS SURROUNDINGS.

unites with the navigation canal and flows out into the lower level of the river. The forebay is also provided with discharge openings and a large waste weir of 90 metres (295 feet) width communicating with a terraced outlet to the lower level of the navigation canal, thus carrying off the surplus water to the river below.

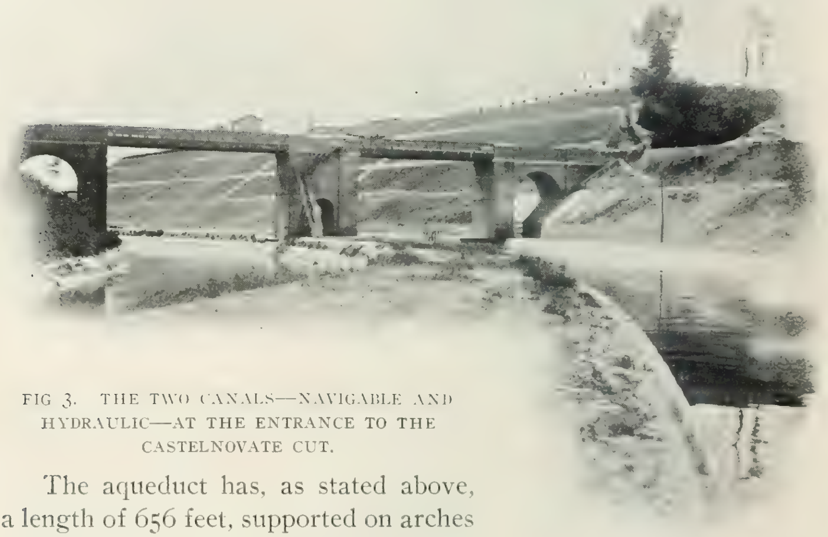


FIG 3. THE TWO CANALS—NAVIGABLE AND HYDRAULIC—AT THE ENTRANCE TO THE CASTELNOVATE CUT.

The aqueduct has, as stated above, a length of 656 feet, supported on arches of 4.8 metres (15.74 feet) span and 33½ inches thickness at the keystone, of concrete construction, resting upon heavy pile foundations of various depths, in solid earth. The normal depth of the water in it is 3.5 metres (11.4 feet) with its mean surface 10 metres (32.8 feet) above the ground level, and a velocity of flow of 3 metres (9.8 feet) per second. At the end of the aqueduct is the forebay, an enlargement necessary to reduce the velocity of the water and permit it to flow into the turbines without undue loss of head. Its construction is similar to that of the aqueduct. In the right-hand wall twelve circular openings, protected by a large grill and furnished with vertical-lift gates, having electric and hand control, lead to the twelve penstocks (Figures 8 and 9). On the left-hand wall, near the lower end of the basin and near the middle are three discharge gates, and at the upper part is a great waste weir 90 metres (295 feet) wide, which permits the surplus water to flow over without inconvenience even in case of the sudden closing of all turbine gates. At the base of this left-hand wall of the basin is a reservoir floored with cencrete one metre thick and protected by a layer of water of the same thickness, which receives the surplus water of the forebay and the outflow of the terraced outlet (of masonry) which has a descent of about 20 metres (65.6 feet). These waters then flow into the low level of the navigation canal and thence return to the river.

Of all the ingenious works of this installation the aqueduct and the forebay in which it ends are certainly the points of greatest interest. Considering the amount of water which it carries this is one of the largest structures of its kind ever built. Questions concerning its strength and the impermeability of its walls and, above all, of the effects of unequal expansions and contractions in this immense block of concrete a thousand feet in length, were the subject of careful and prolonged study and research.

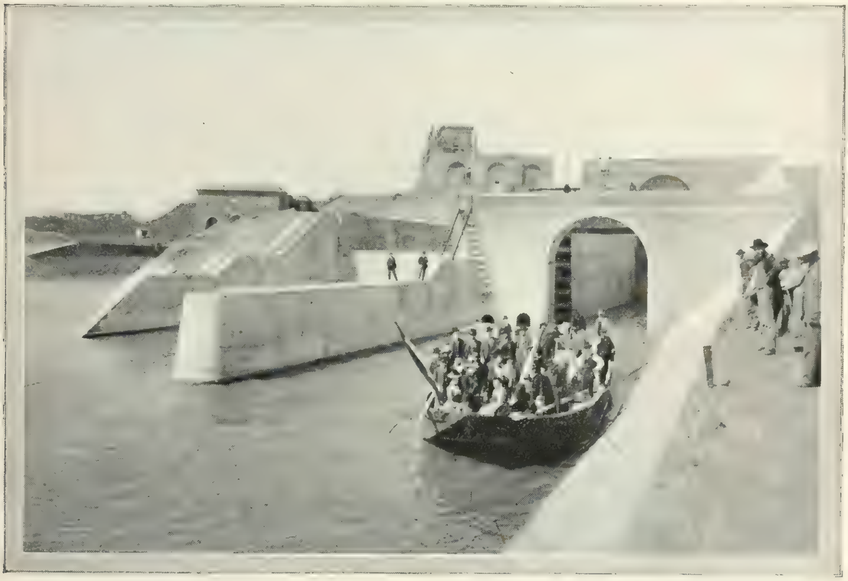


FIG. 4. THE NAVIGABLE CANAL AT ITS TERMINUS NEAR THE POWER PLANT.

Ordinary concrete, even in masses of great thickness and when made with mortar rich in cement, is always permeable to water. Only a tight, smooth and continuous lining is able to protect it. But this is a protection which is immediately spoiled when, either on account of the unequal disposition of the elements of construction or their displacement following expansions and contractions, cracks, even of the smallest, are formed. These cracks or actual discontinuities are inevitable in this mass of about 25,000 cubic metres of concrete, unevenly distributed over a length of about a thousand feet and also unequally exposed to temperature variations. It became necessary, then, to guard against their consequences. The measure adopted (see the sections of the aqueduct, Figures 10 and 11) was to make a double wall and bottom for the aqueduct and forebay with three superposed layers of tarred felt, forming thus a practically impermeable partition in the interior of the mass and one which, even if subjected to great compression or extension, would give considerably without losing its continuity. This partition, much less rigid and much more perfectly watertight than the concrete, prevents any evil effects of cracks in the latter or of infiltration of water.

Such are the salient features of the Vizzola Ticino installation. Its importance may be judged, better than from any amplified description, from the following figures of its more important features:

Excavation	1,100,000	cubic metres
Masonry (90 per cent. concrete, 10 per cent. bricks, rubble, etc.)	90,000	cubic metres
Surfacing (linings, pavements, flooring, etc.)	50,000	square metres
Days of work of excavators, masons, etc.	650,000	

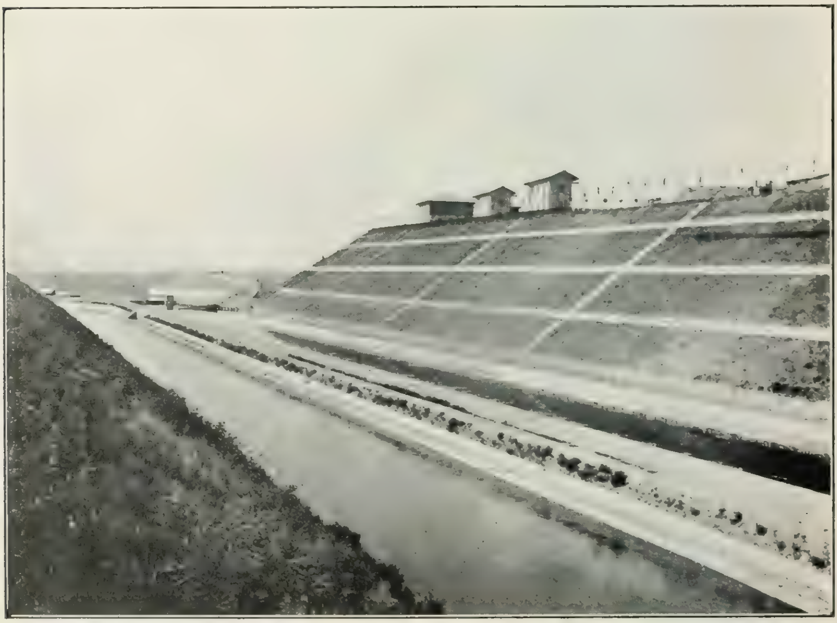


FIG. 5. THE VILLORESI HYDRAULIC CANAL AND THE NAVIGABLE CANAL IN THE GREAT CUTTING AT CASTELNOVATE.

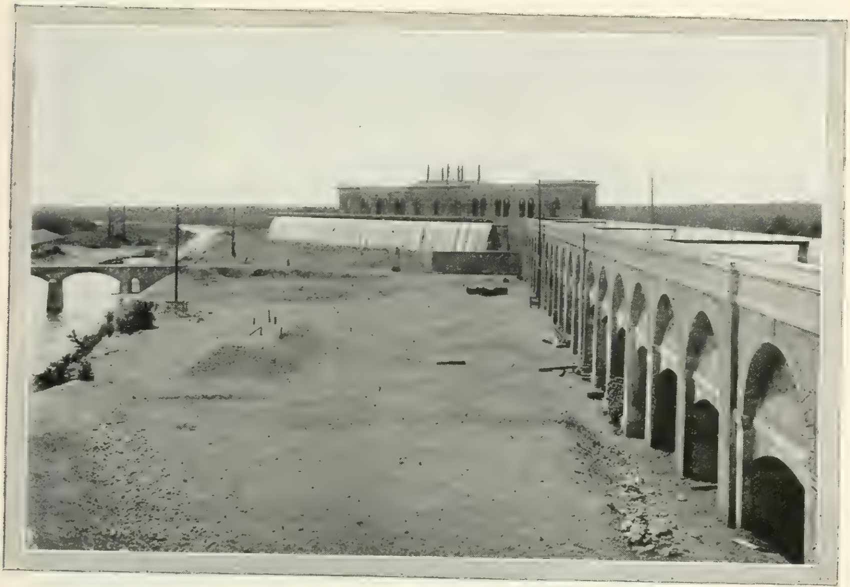


FIG. 6. THE AQUEDUCT BRIDGE AND THE GREAT WEIR, 80 METRES LONG, OF THE HEAD BASIN.

The regulation of Lake Maggiore to serve as a reservoir, by means of the construction of a movable dam, will assure to the power canal at Vizzola a constant flow at low water of 65 cubic metres per second, corresponding to 24,000 horse power. Looking forward to this rate of working all of the works have been constructed susceptible of enlargement to these dimensions.

The Water-Power-Electric Installation. From the forebay at the foot of the aqueduct the water is led in twelve steel penstocks to the turbines. Here commences the electrical installation which comprises the following elements:

The power house for the production of electrical energy, commonly called the central station.

The electrical transmission line.

The receiving installations.

The central station produces its electrical energy under the form of high-tension three-phase alternating current. The generating units are ten in number, each consisting of a 2,000-horse-power turbine wheel direct-coupled to a three-phase generator of corresponding size (Figure 12, page 196). Since the territory in which the most of the power generated at Vizzola is consumed is situated from 15 to 18 kilometres from the station, it was decided to adopt a primary

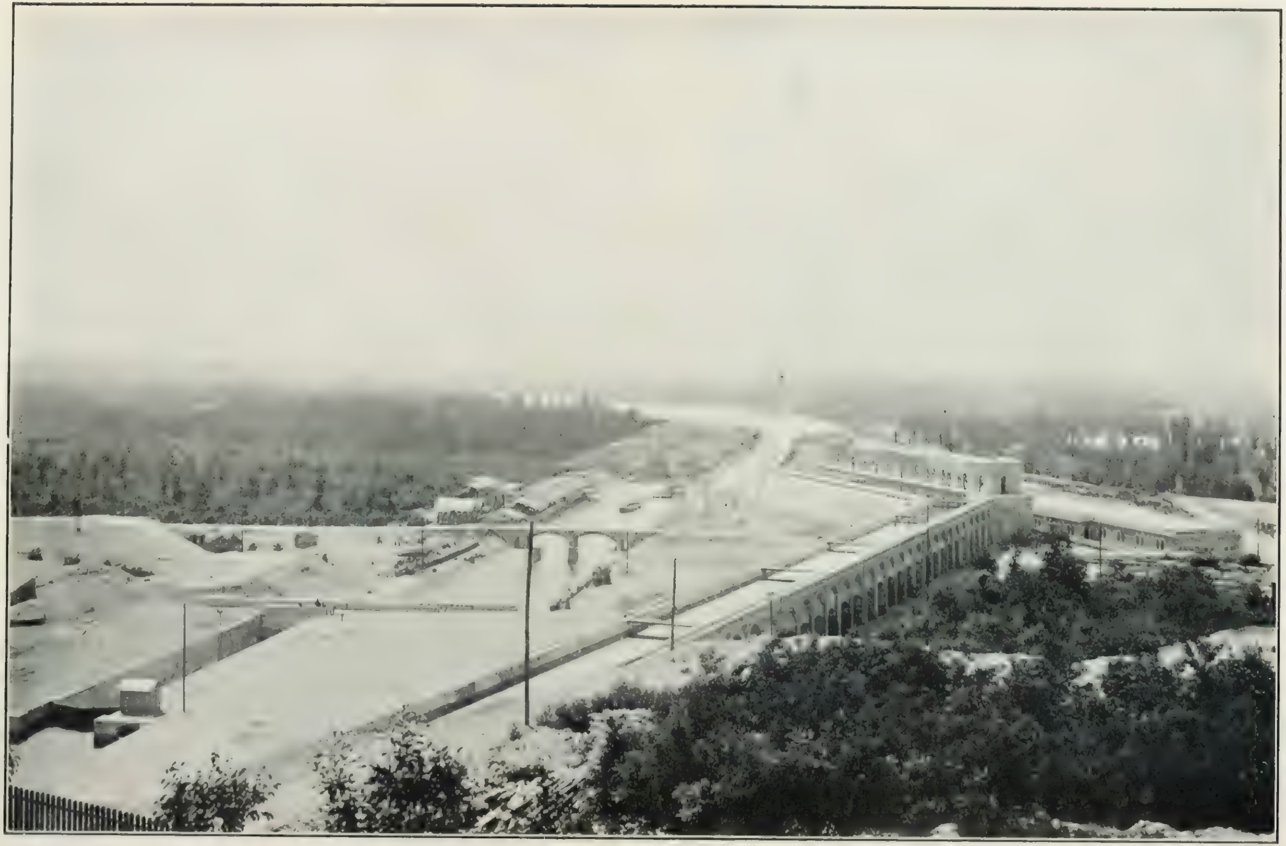


FIG. 7. VIEW OF THE AQUEDUCT BRIDGE, THE HEAD BASIN, AND POWER PLANT FROM THE RIGHT BANK ABOVE.

tension of 11,000 volts, generated directly by the dynamos. In addition to the power-generating machines two smaller direct-current units have been installed to furnish exciting current for the large dynamos and current for the accessory services of the central station, such as power for the repair shop, the electric crane, the movement of the control gates, and for lighting. These two units each consist of a 220-horse-power turbine direct-coupled to a continuous-current dynamo (Figure 13). The total capacity of the turbines is thus 20,440 horse power, of which 2,000 horse power is held as a reserve. The station, as well as all the auxiliary distributing and transmitting installations, was constructed upon the designs of Signor A. Scotti, engineer and director of the Società Lombarda, which owns and operates the plant.

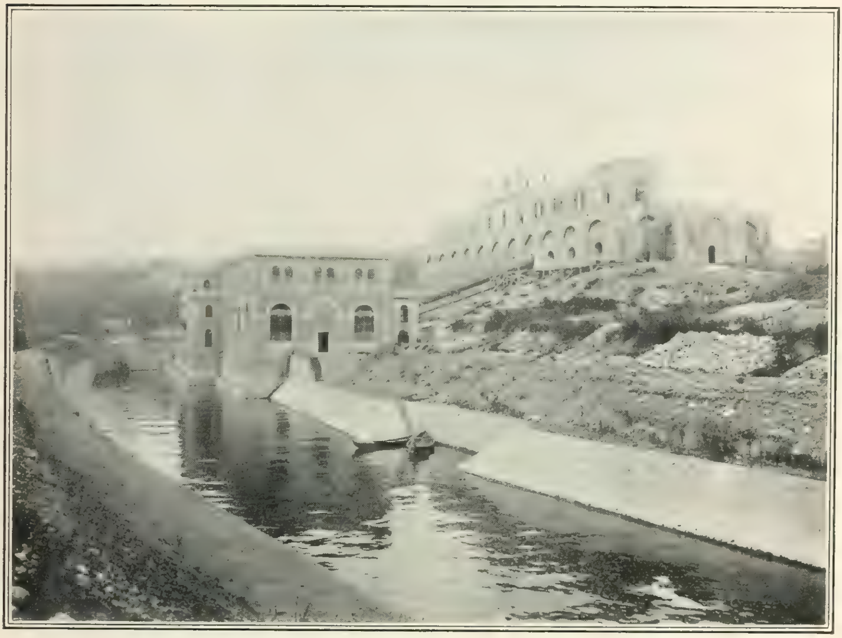


FIG. 8. CENTRAL HYDRO-ELECTRIC STATION AT VIZZOLA.
Head basin, gates, and penstocks on the right; power house below on the left.

The Turbine Wheels. Seven 2,000-horse-power wheels were put in for the first installation, of which five were built by Riva Monneret & Co., of Milan, and two by J. M. Voith, of Heidenheim, Germany. All the wheels are of a similar type, having horizontal shafts with two runners and two distributors of the twin type, introducing the water radially from the outside. Discharge is by means of draught-tubes and the head varies from 28 metres (92 feet) at time of low water to 24 metres (78.7 feet) during freshets. The guides carry steel baffle plates and the gates are of the revolving balanced type. The wheels run at 187 revolutions per minute and the shafts end in flanges for rigid coupling to the dynamos. Automatic regulation is obtained by means of auxiliary apparatus on the Riva wheels and by mechanical auxiliaries on the Voith wheels.

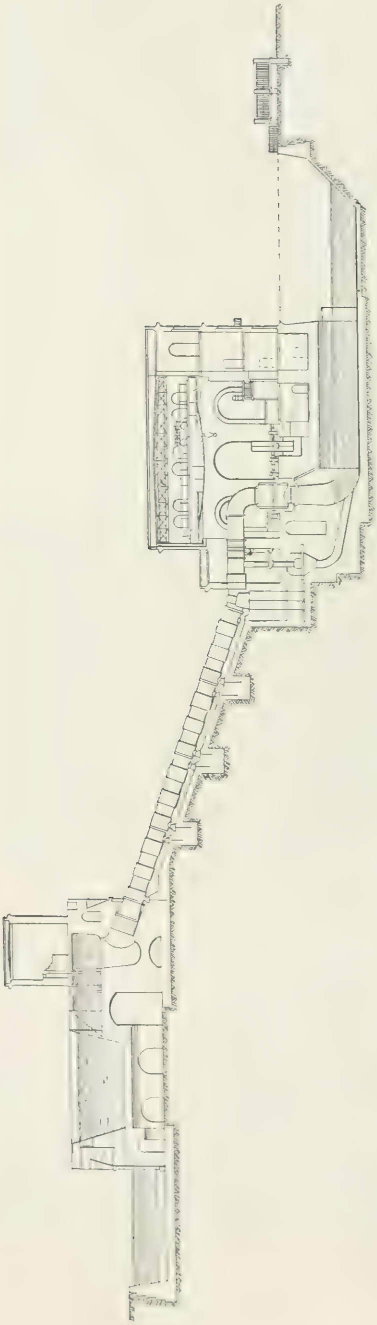


FIG. 9. GENERAL LONGITUDINAL SECTION OF FOREBAY, PENSTOCKS, AND HYDRO-ELECTRIC STATION.

All of the dynamos and other electrical apparatus were built by the Elektricitäts Aktien Gesellschaft, formerly Schuckert & Co., of Nürnberg. The main generators are of the three-phase type having stationary armatures and revolving fields excited by a single coil. Their normal capacity is 1,650 kilowatts at 11,000 volts and 50 cycles per second. The two exciters are ordinary direct-current machines, rated at 145 kilowatts at 110 volts.

All the accessory apparatus are assembled on two switchboards, in rooms one above the other on different floors of a building designed for them. The control apparatus for the dynamos are on the lower board and those for the lines on the upper board. Lightning arresters are assembled in a third room, entirely separated from the others, outside of the dynamo building at the end of the transmission line.

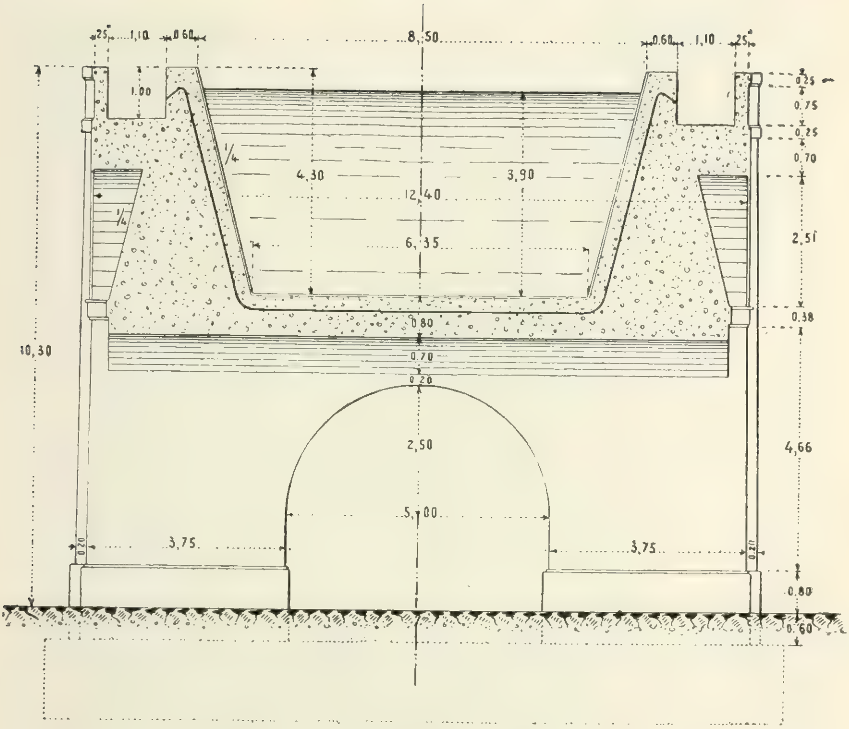


FIG. 10. SECTION OF THE AQUEDUCT. DIMENSIONS ARE IN METRES.

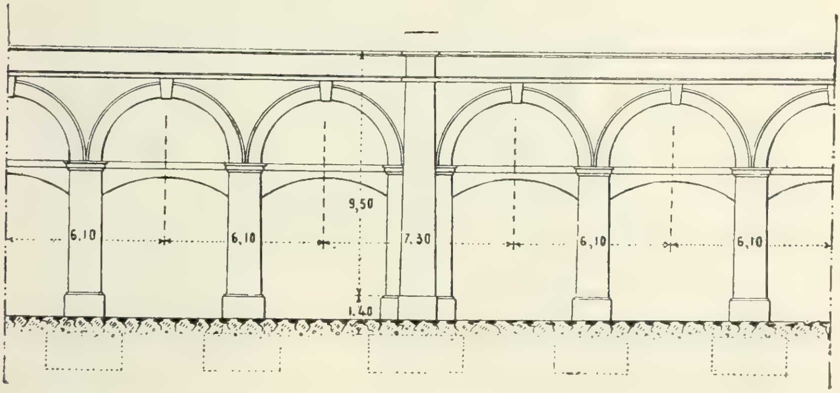


FIG. 11. ELEVATION OF THE AQUEDUCT. DIMENSIONS ARE IN METRES.

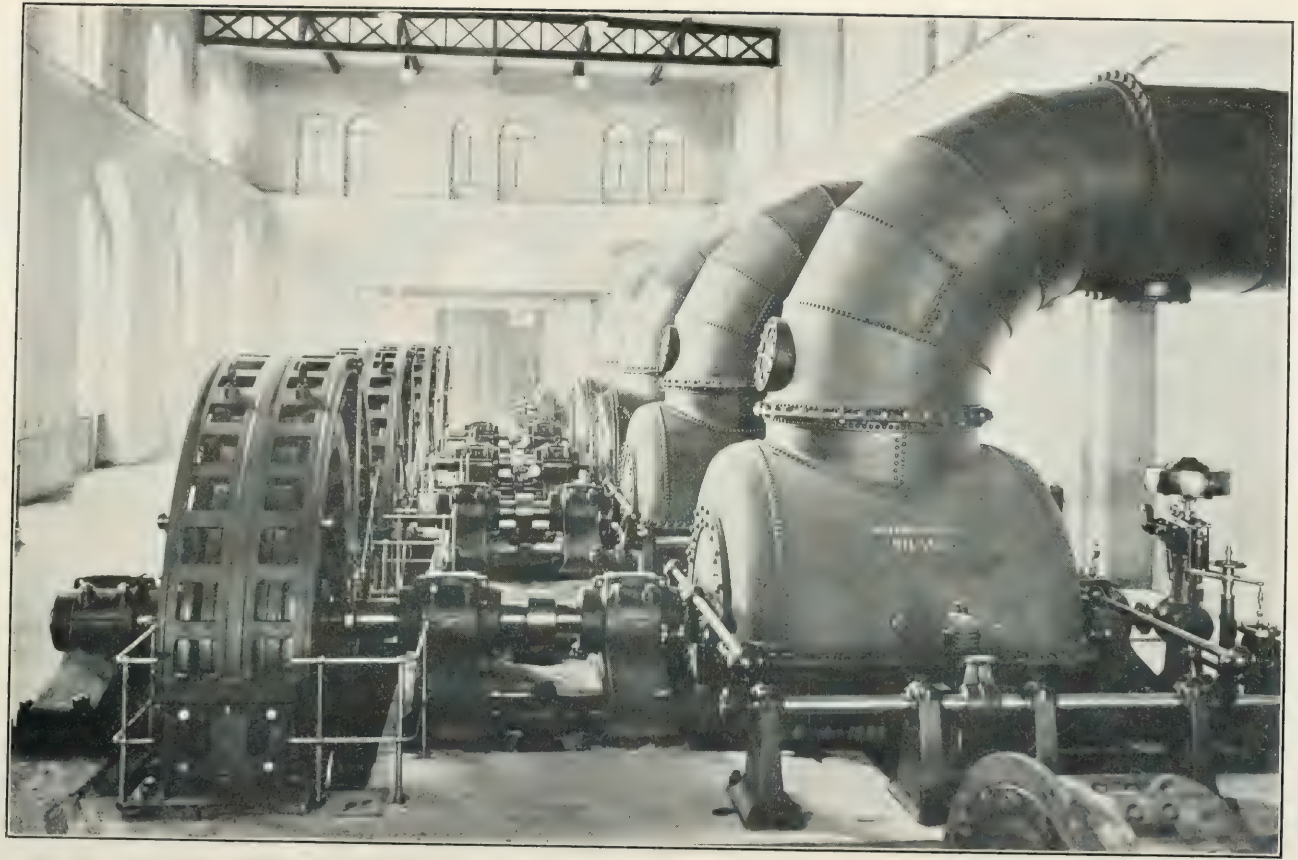


FIG. 12. THE POWER HOUSE. THE TURBINES, OF 2,000 HORSE POWER EACH, ARE COUPLED TO SHUCKERT ALTERNATORS OF 1,650 KILOWATTS AT 11,000 VOLTS.

Transmission Lines. Milan is about 40 kilometres (25 miles) from this power development, which is in one of the richest industrial regions of Italy, comprising the manufacturing centres of Gallarate Busto Arsizio, Legnano, respectively 10, 15, and 18 kilometres from Vizzola, and Valle Olona, in which the single industry of cotton manufacture (which prospers there on a solid basis and from ancient times) employs more than 10,000 horse power generated by steam. Among the manufactories taking power from the Vizzola plant may be mentioned Banfi & Co., cotton weavers, of Legnano, (Figure 16 and 17), using about 1,800 kilowatts and presenting several ingenious adaptations of electricity to a manufacturing establishment hitherto entirely steam-driven. Others are the Cotonificio Cantoni, at Castellanza and Legnano, using 800 kilowatts; Carlo Ottolini, at Busto, taking 600 kilowatts; and the spinning establishments of A. A. Ponti at Solbiate; Luigi Candiani at La Garottola, and Somaini & Co., at Lanagro with 400 kilowatts each. In Figure 14 are shown the transmission lines.

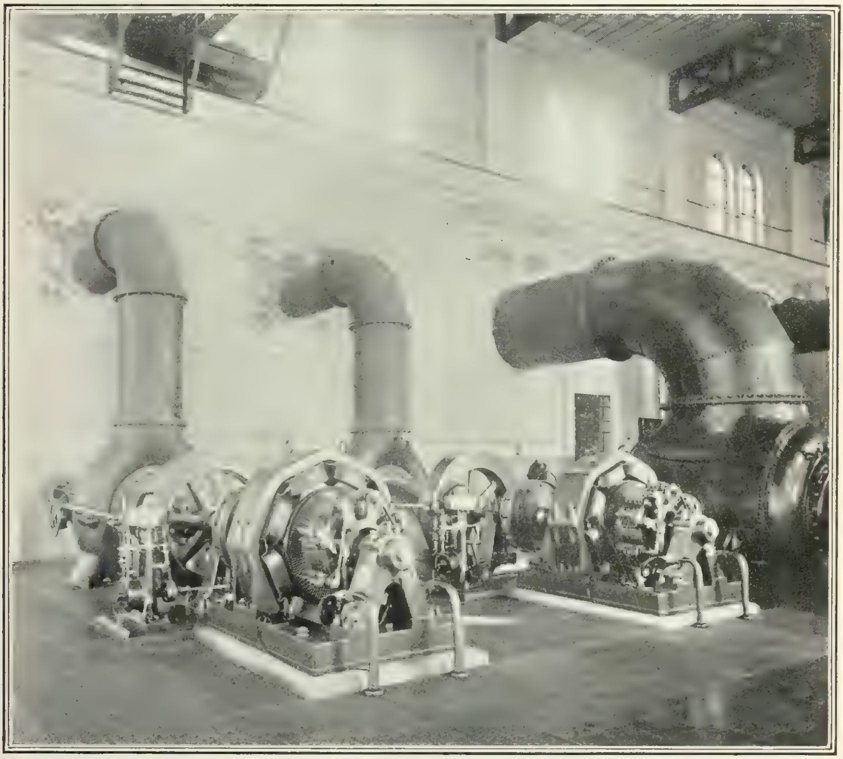


FIG. 13. CONTINUOUS-CURRENT EXCITER DYNAMOS OF 145 KILOWATTS AT 110 VOLTS, COUPLED TO 220-HORSE-POWER TURBINES.

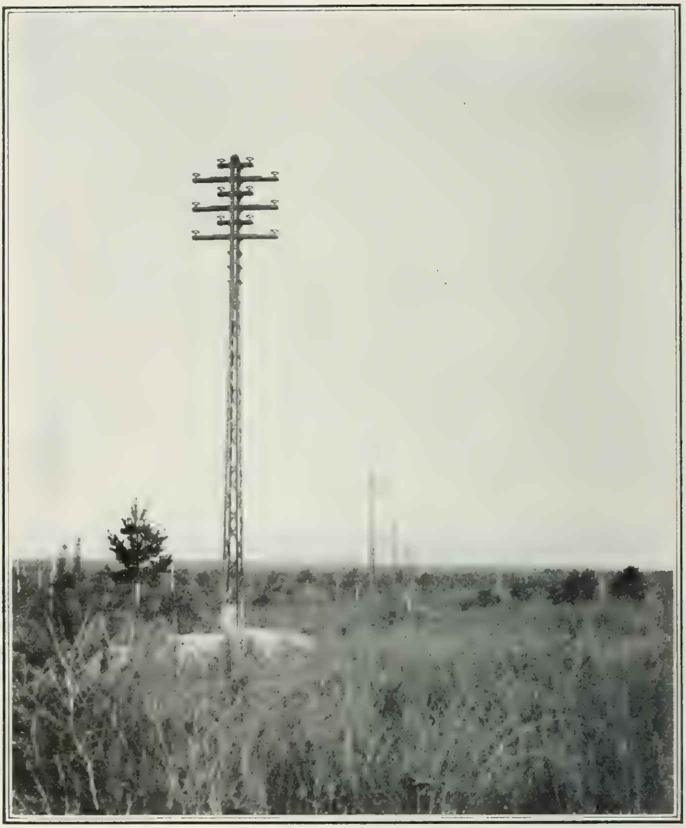


FIG. 14. TRANSMISSION LINE CROSSING THE MOORS OF GALLARATE.

From considerations of safety and ease in handling, each centre of consumption has its own transmission line from the central station, which can be made entirely independent of the others. Lighting, in the principal centres of Gallarate, Busto Arsizio, and Legnano, is carried on over circuits independent of the power-transmission wires. All of the 11,000-volt primary lines are overhead and are carried on poles partly of wood and partly of iron, with triple-bell porcelain insulators The poles, lines, and insulators are shown in the illustration above.

Receiving Installations. In the principal centres of consumption requiring a widespread distribution of energy among numerous small consumers, as at Gallarate, Busto Arsizio, Legnano, and Saronno, the primary lines feed a transformer station (transformers of a normal type, of 200 kilowatts), from which a secondary distribution at 3,600 volts is made. The customers receive current either at this pressure

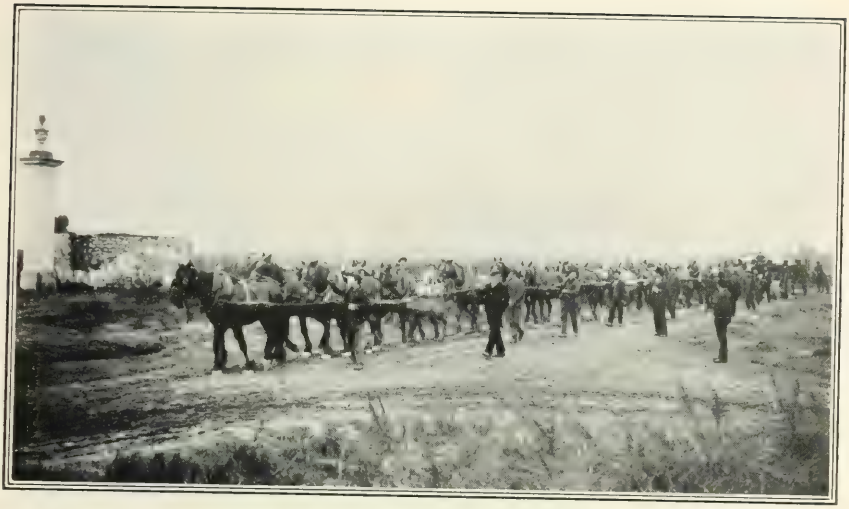


FIG. 15. TRANSPORTING DYNAMOS ACROSS THE GALLARATE MOORS.

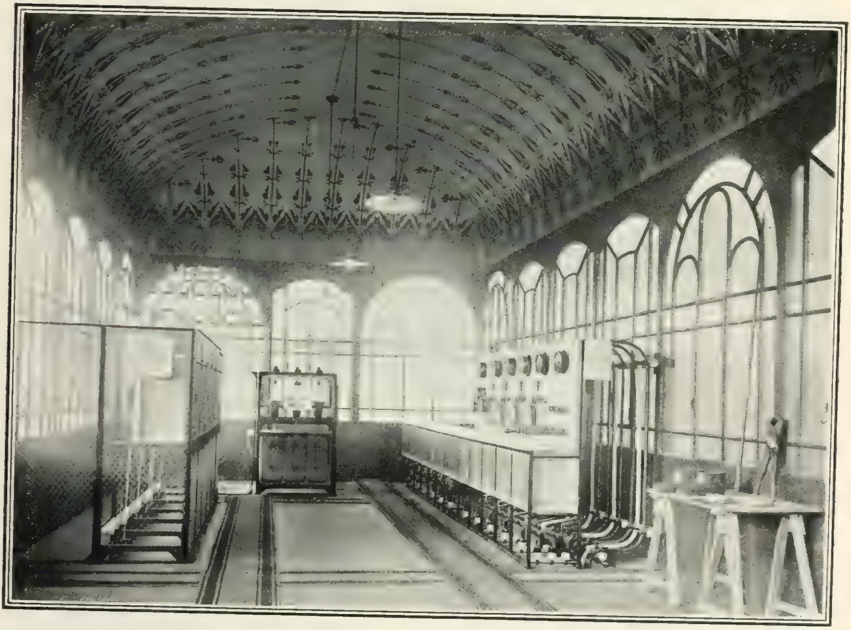


FIG. 16. SWITCHBOARD ROOM AND MEASURING APPARATUS AT THE RECEIVING STATION OF THE WORKS OF FRUA BANFI & CO., LEGNANO. 2,500 HORSE POWER.

or, after a second transformation, at 125 volts (Figure 19). The transformers were furnished by Brown, Boveri & Co., of Baden, Ganz & Co., of Budapest, and Schuckert & Co., of Nürnberg. The large consumers, such as the large weaving and spinning establishments at Valle Olona and those near by, have their own transformer installations on the 11,000-volt primary, furnishing them with 500-volt current. The power company's installation proper terminates at the secondary terminals of these transformers.

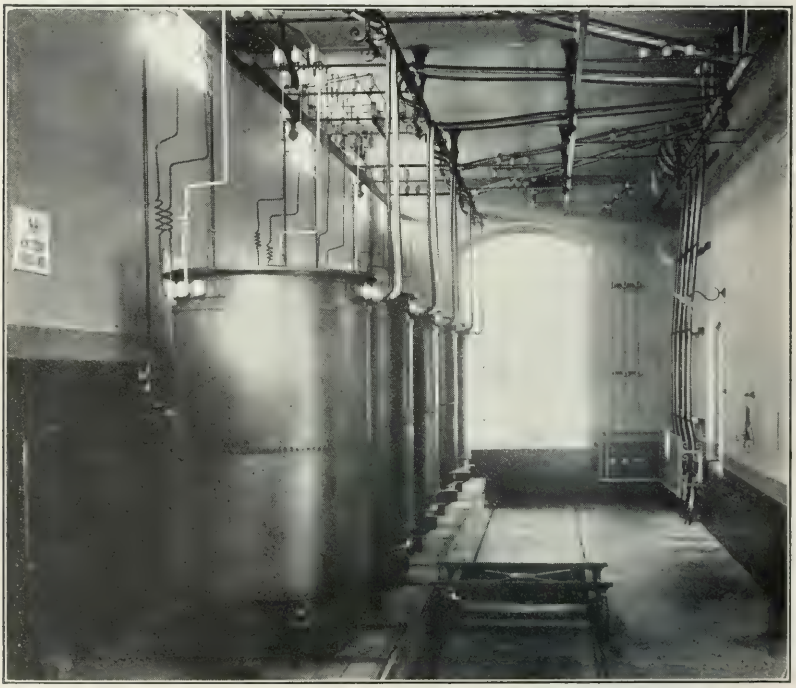


FIG. 17. RECEIVING STATION OF FRUA BANFI & CO., LEGNANO.
Five transformers of 500 kilowatts each reducing 1,000-volt current to 500 volts.

The contracts for power already closed, which absorb all the output of the first installation, are based on the forfeit principle; that is, on a given price per kilowatt per year and for all the kilowatts bought by the consumer. The price varies between a maximum of 400 lire (£16 or $80) for installations under 5 kilowatts, and a minimum of 160 lire (£6 8s. or $32) for consumers using over 700 kilowatts for periods of 12 hours. This "flat rate" method, possible with installations of this character, has resulted in facilitating the sale of power, simplifying the installations, and reducing the costs of opera-

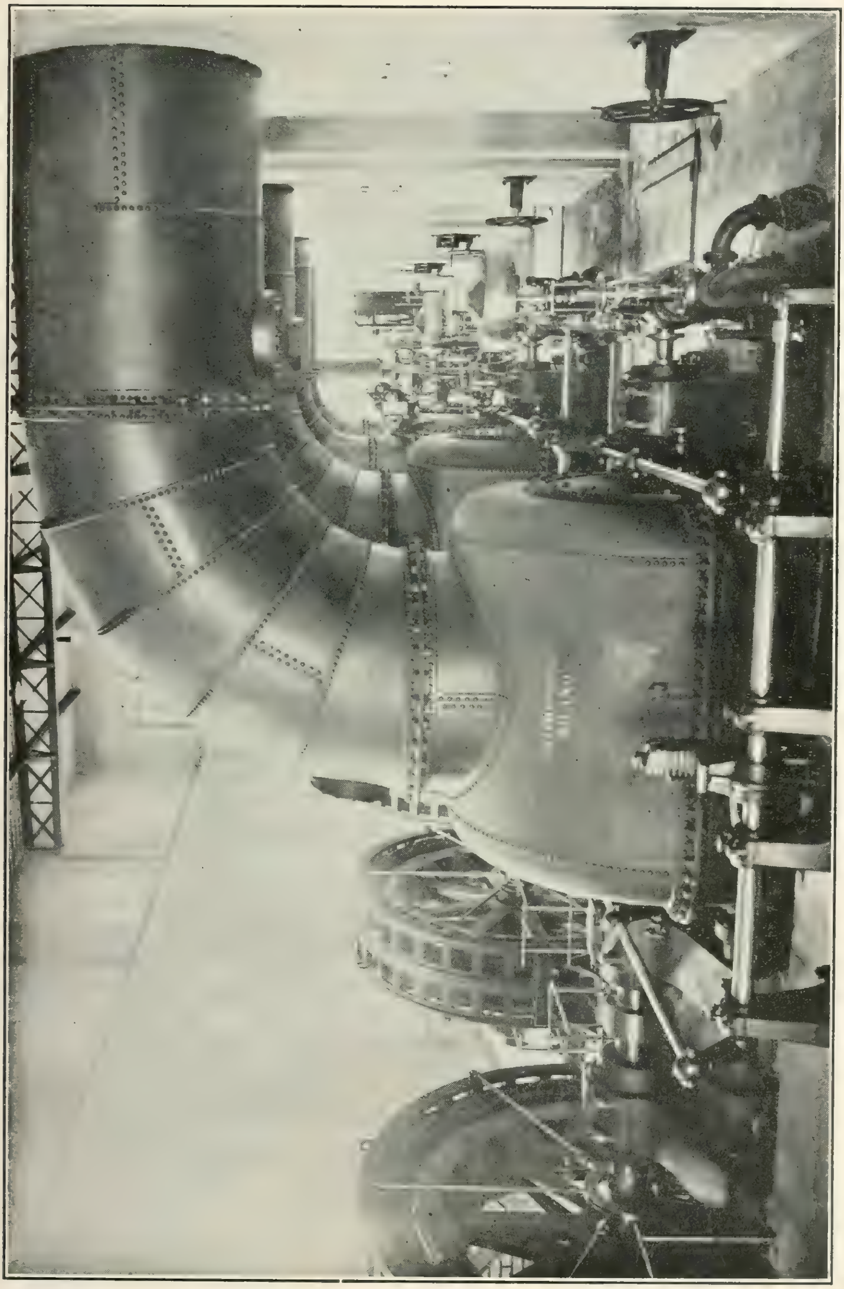


FIG. 18. THE 2,000-HORSE-POWER TURBINES BUILT BY RIVA, MONNERET & CO., OF MILAN.

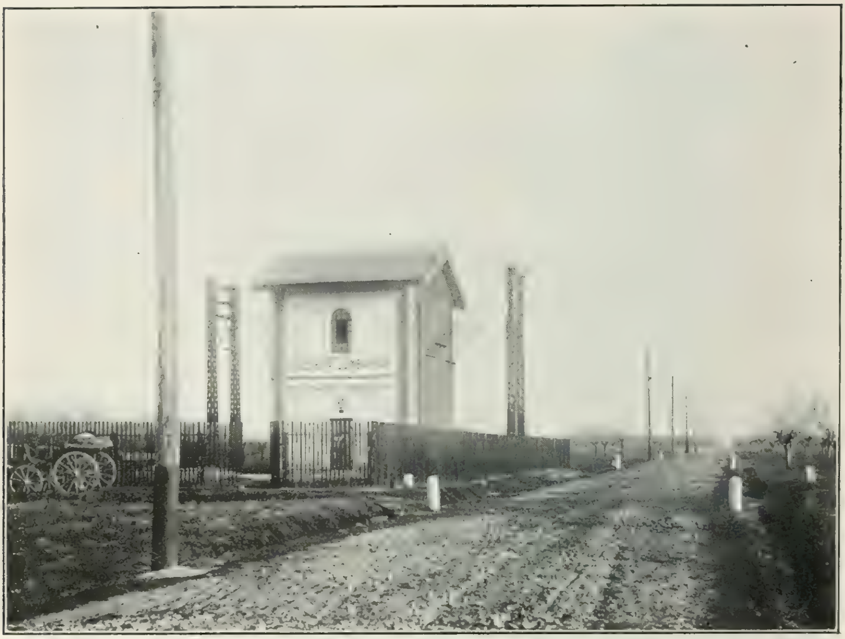


FIG. 19. SUBSTATION OF THE VIZZOLA-TICINO INSTALLATION, FOR TRANSFORMING FROM 11,000 VOLTS TO 3,600.

tion. It has contributed largely to the good results attained in 1900 and exhibited in the statement just made to the general meeting of the company, in which the administrative council was authorized to put out more than 100,000 lire of new shares.

The Vizzola-Ticino installation is today, in power output, the largest of its kind in Europe and the most important also of a series of others that will soon utilise the residual powers of the river Tessin between Sesto-Calende and the Po—powers estimated at 20,000 horsepower and which will be employed also for electric traction.

THE MINING DEVELOPMENT OF GILPIN COUNTY, COLORADO.

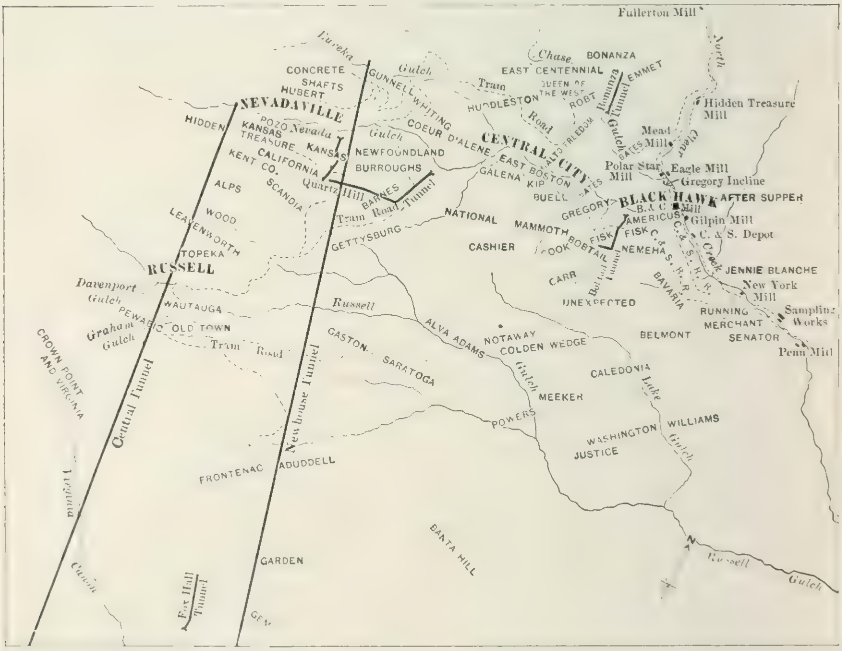
By Thomas Tonge.

The characteristics of modern mining, which have put it upon a sound basis commanding the confidence of any required amount of capital, are rigorous and thorough engineering methods of examination, economical working by the aid of mechanical appliances, and minimising of general cost burdens by "intensified production." These three tendencies of modern practice are well exemplified in the region described in this article by Mr. Tonge.—THE EDITORS.

GILPIN COUNTY, while the very smallest in area, is one of the important mining counties of Colorado and is specially interesting for the following reasons. (1) It was the scene of the first lode mining in Colorado, namely, in May, 1859, since which time the county has produced over $100,000,000 worth of mineral, mostly gold, and principally from a small belt of territory about four miles long by two-and-a-half miles wide, of which Central City is approximately the centre. In such limited area there are ten mines which have passed the $1,000,000 mark in production, and thirty-six of the leading mines have produced $60,000,000. (2) Placer mining was conducted in Gilpin County contemporaneously with its first employment in Colorado. (3) The first successfully operated smelting plant in America was established at Black Hawk in this county. (4) The infinite number of the mineral-bearing fissure veins and the lateral and vertical continuity of some are phenomenal. (5) The district is an interesting illustration of the evolution of mining and metallurgy and the steady reduction of operating expenses. (6) After forty-two years of practically continuous operation, the local mining industry, with the improved mining and metallurgical methods now in vogue, has obviously a future much greater than its past.

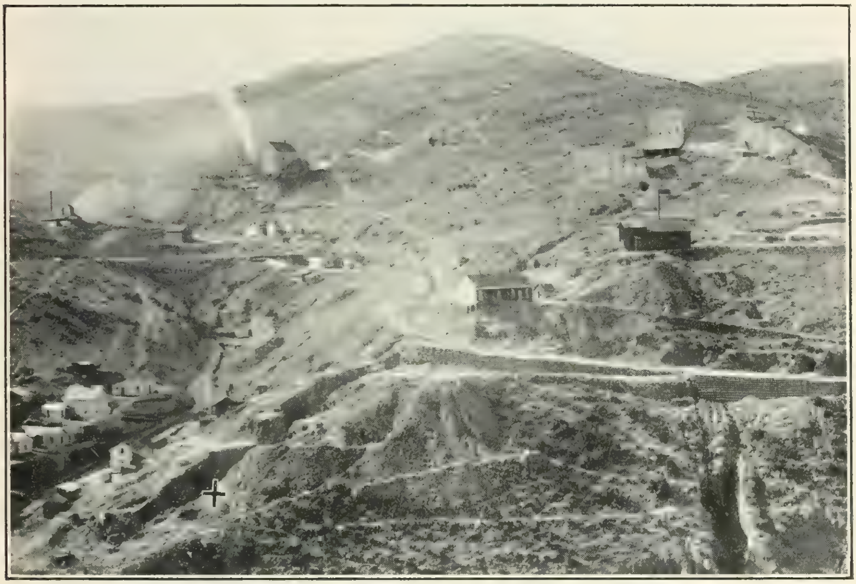
On 6th May, 1859, as stated in Fossett's "Colorado" (1876), John Gregory, a prospector, climbed the hill into what is still known as

Gregory Gulch (midway between the present Central City and Black Hawk), scraped away the grass and leaves, filled his gold pan with dirt, and took it down to the stream. Upon panning (washing) it down, there was about four dollars' worth of gold in it. This was followed by a stampede to the Gregory Diggings, as they were afterwards called. Gregory employed five men from the new arrivals and by means of a sluice took out $972 in one week. Other rich strikes were made almost daily and large amounts of gold were taken out in a short time. The Bates, Bobtail, Mammoth, Gunnell, Burroughs, Illinois and hundreds of other lodes were found and thousands of claims were taken up. As the summer of 1859 advanced, the wealth of the gold veins and gulches of what is now Gilpin County became more and more apparent. Over 15,000 men were congregated in Gregory, Russell, and tributary gulches, and many of them were accumulating wealth rapidly; but everything valuable was soon pre-empted and large numbers were forced to hunt their fortunes elsewhere.



MAP OF THE BLACK HAWK REGION, GILPIN COUNTY. BY GEO. W. SCHNEIDER, E. M.

By the laws adopted by the miners of Gregory District, it was enacted:—(1) That no miner should hold more than one claim, except by purchase or discovery. (2) That each miner should be entitled to one "mountain claim" 100 feet long by 50 feet wide, one "gulch claim," 100 feet up and down the river or gulch and extending from bank to bank, and one "creek claim" for the purpose of washing. Time has increasingly proved that the "mountain claims" were none too large for surface work and entirely too small for deep mining, and the inadequate size of these original claims has been a serious hindrance in the subsequent development of the district. Subsequent to 1872, by local modification of the United States statutes, new claims were allowed to be 150 feet wide by 1,500 feet long, without, however, disturbing the status of the older smaller claims.



GREGORY GULCH, SHOWING EARLY SURFACE WORKINGS.
The Fiske mine is on the extreme left; then come in order the Cook, the Carr (on the ridge), and the Ontario Colorado. The small black cross in the left foreground marks the spot where gold was first discovered.

The surface dirt and "slide" from the veins were at first washed for gold by means of small iron hand-pans and by rockers and then by sluices. As an instance, Spring Gulch in 1860 yielded two ounces of gold to the man per day, or about $35. Arrastras were subsequently utilized in grinding up the dirt and surface quartz, and answered very well until the contents of the veins became so hard as to require stamps. An arrastra, run by ox-power, was started up in June, 1859, and a water-power arrastra in the following month, with a daily capacity of twelve tons of comparatively soft surface ore. Other arrastras followed. During the remainder of 1859 several small, primitive stamp-mills were established locally, and in 1860 other stamp mills arrived by the score. At first, they were rude, imperfect affairs and destitute of copper-plated tables. After the surface quartz was exhausted and the miners had sunk down in the veins to the iron pyrites, they saved but little gold and the mill men in 1861-2-3-4 were often unable to obtain the gold even on copper-plated tables, owing to their inexperience. From 1864 to 1867 followed an era of "process mania," which was still worse than the incapacity of the pioneer mill men.

In 1867 there was erected, at Black Hawk, a smelting plant of twelve-tons daily capacity, consisting of one reverberatory and one calcining furnace, with the requisite machinery for crushing, pulverizing, etc. It commenced operations in January, 1868, and proved a success. The result was that the miners, finding a ready cash market for their ore, began to operate their abandoned claims and the local mining industry commenced a career which has ever since been maintained. As illustrating the local conditions at the time of the commencement of operations by this pioneer smelter, it may be stated that every single fire-brick used in its construction cost $1.00, having to be brought by wagons about 600 miles from the nearest point on Missouri River and to that point by railroad from St. Louis; the iron cost 22 cents per pound; the pay of skilled labor was $8 per day, and of common labor, $4 per day; and the charge for smelting ranged from $20 to $45 per ton. There was no railroad nearer than the Missouri River, about 600 miles away; wagon transportation was high, as also were all the necessaries of life. Moreover, the "matte," the product of the plant, in the absence of any local means of separating or refining, had to be hauled to the Missouri River in wagons, thence by railroad to New York, and thence to Swansea, Wales, where it was separated and the gold, silver and copper refined.

The impetus so given to the local mining industry by the establishment of the smelter at Black Hawk also beneficially affected the local stamp-milling industry, treating the ore too low-grade to send to the smelter. In 1875 there were twenty-two mills in the county, aggregating four hundred and forty stamps. In October, 1876, the number of stamps dropping had increased to seven hundred and seventy. In 1901, on the North Fork of Clear Creek, in the vicinity of Black Hawk, there are twelve stamp mills, comprising nearly six hundred

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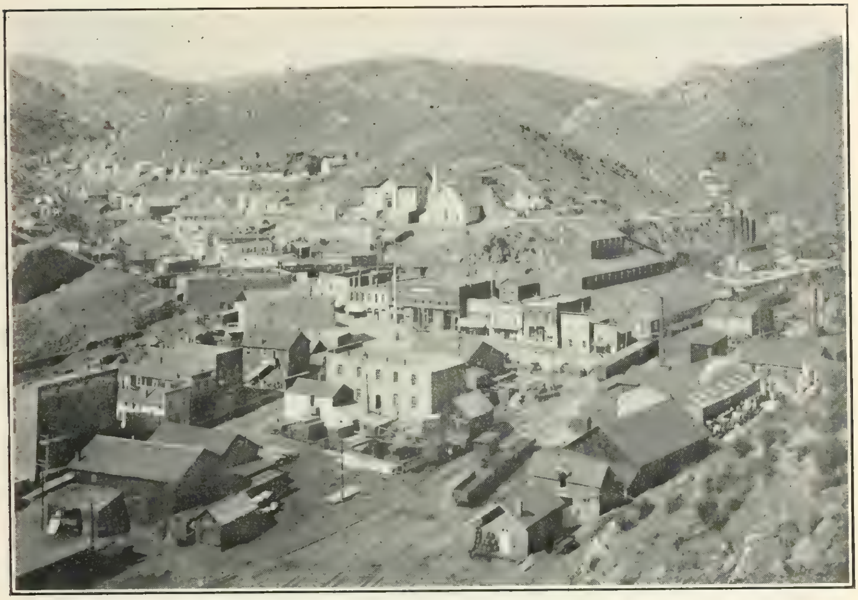
(NOTE.—This smelting plant was moved from Black Hawk to Argo, near Denver, in 1878 and for many years past has had a daily capacity of 200 tons, and its own refinery producing gold and silver bullion and pig copper.)



GENERAL VIEW OF BLACK HAWK.

The Boston and Colorado 80-stamp mill is directly in the right foreground.

stamps, of which about four hundred stamps are "slow-drop," averaging from twenty-eight to thirty-two drops per minute, with a crushing capacity of from $^1/_2$ to $^2/_3$ of a ton of ore per stamp, per day of twenty-four hours. The remaining two hundred stamps are "rapid drop" ranging from sixty-five to ninety drops per minute, with a crushing capacity of from $1^1/_2$ to 3 tons of ore per stamp, per day of twenty-four hours. There are various other similar mills in other parts of the country.

In 1901 there are about one hundred properties, large and small, more or less regularly shipping ore. There are in addition quite a number of dormant properties, merely awaiting new enterprise, new capital, consolidation of adjoining claims, and modern mining methods, to become ore-producing, dividend-paying mines. Apart from the comparatively large amount of Colorado capital invested in the mines of the district, many of the properties represent capital from New England, New York, Philadelphia, Pittsburg, Chicago, Detroit, St. Louis, St. Joseph, and other American financial centres, and also from Canada, England, Belgium, etc. The great majority of the mines are owned, not by ordinary mining stock companies, but by private companies, syndicates, or private individuals. No Gilpin County mine is listed on any stock exchange.

The last biennial report of the Colorado State commissioner of mines shows that in the mines and mills of Gilpin County, in 1900, there were 3,124 men employed, as against 3,017 in 1899, and for 1900 the State commissioner estimates the mineral output as $1,967,550, of which $1,655,501 was gold and the rest silver, lead, and copper. It may here be observed that there are no better miners than those of Gilpin County anywhere in Colorado or the world. There is a considerable number of Cornishmen and Welshmen. Speaking generally, the Gilpin County miner takes care that his children are educated and is a supporter of churches rather than of saloons. The local standard wages for miners are from $2.50 to $3 per day for nine-hours work. There has never been a miners' strike in the county, and the two national banks at Central City have $1,000,000 on deposit, largely representing the accumulated savings of the miners.

The infinite number of the local fissure veins and the continuity laterally and vertically of some of them calls for special mention. Quartz, Gregory, Bobtail, Gunnell and other hills are one vast net-work of veins, with here and there huge deposits of ore—some of them of great value. There are a number of main veins with an infinity of comparatively minor parallel, diagonal, and cross veins.

The Gregory, the first gold-bearing lode found in Colorado, named after its discoverer in 1859—John Gregory—has been one of the most productive lodes in Colorado and one of the most widely known, its past record production being upwards of $15,000,000. It has been operated, more or less, for at least a mile in length, the greatest depth hitherto attained being about 1,000 feet. The surface dirt was washed in the gulch by sluices and was exceedingly rich. The Bobtail vein, with a past record of production of upwards of $8,000,000, begins on Bobtail Hill at Black Hawk, and running west is operated in a series of properties to an aggregate length of one mile. It is now believed by some that it is a continuation of this vein that is found on the opposite side of Spring Gulch on Quartz Hill, in the California and other properties, for a further distance of one and a half miles, thus making, if this theory is correct, a total length of two and a half miles. The Fisk vein, so far as known, begins near Black Hawk and is operated, in a consecutive series of properties, for over half a mile. The Gunnell vein, with a past record production of several million dollars, has been opened and is now worked for the distance of a mile in length. The Frontenac vein extends through a succession of properties and over the line into Clear Creek County, having been opened up and operated for a total length of over one and one-half miles. Several other veins of great length could be mentioned, those referred to specifically being merely typical of the district.

As to the continuity vertically, experience has shown that in many cases surface veins unite with depth and jointly form a large vein which continues with great depth. The California shaft is 2,250 feet deep, while in the limited mineral belt surrounding Central City there are several shafts over 1,200 feet deep and perhaps twenty shafts ranging from 700 feet to 1,200 feet, all still in ore. In the same belt, near the dividing line between Gilpin and Clear Creek counties, the Newhouse Tunnel, 15 feet by 12 feet in size, recently intersected the Gem vein at 2,000 feet below the surface, following the dip of the vein, and 1,400 feet vertical depth. In merely driving the tunnel through this Gem vein, at right angles, 13 tons of smelting ore and 116 tons of mill dirt were taken out, which netted $1,150. The streak of smelting ore and mill dirt at the point of intersection is nine feet wide, the vein itself being considerably wider.

NEVADAVILLE. HIDDEN TREASURE MINE ON THE LEFT, CALIFORNIA MINE (WITH A SHAFT 2,250 FEET DEEP) ON THE RIGHT.

The State commissioner of mines, in one of his annual reports, says of Gilpin County :—

> "The veins are true fissure veins and vary in width from two to twenty feet. Associated with the brecciated and impregnated gangue, regular streaks of 'solid ore' are not uncommon, usually carrying higher values. These are separated and shipped as 'smelting ore.' The remaining part is mined and shipped as 'mill dirt.' The ores are iron and copper pyrites, galena, and zinc blende, with ordinary associated minerals, the principal values being in gold. The gold and silver contents vary in value from a few dollars to several hundred dollars per ton."

He also says:—

> "Many customs inaugurated with the establishment of this district are still in vogue. For example, all mill ore is estimated by the 'cord.' A 'cord' in this section contains between 7 and 8 tons of ore by weight, and is usually estimated at 8 tons. The contract system in mining is quite common. Originally all work was let by the 'fathom,' i. e., 6 feet; but of late shaft and drift contracts are let by the foot (12 inches) and ore stoping by the fathom, i. e., 6 feet along the vein by 6 feet high. Smelting ore, on the other hand, is transported and sold on the ton basis of 2,000 pounds. To the uninitiated, the combination is somewhat confusing, especially when a mine manager speaks of shipping two-ounce gold ore and milling two-ounce gold ore; the former meaning two ounces per ton, and the latter two ounces per cord or eight tons. Even more is implied in regard to milling ore, viz., two ounces per cord is understood to mean the amount of gold saved by amalgamation, does not include the value of concentrates saved or contained, and, therefore, has no reference to the gross value of contents."

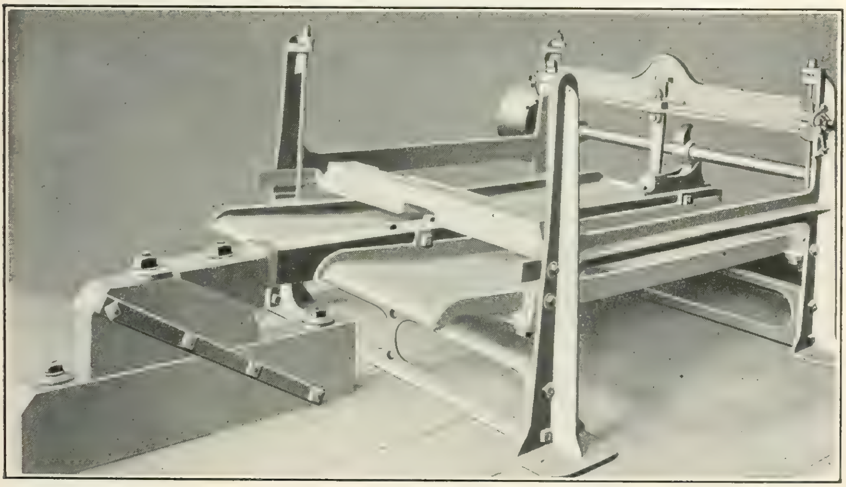
Speaking generally, there are three classes of local ore, viz:—(1), smelting; (2), milling; and (3), concentrating. Bobtail Hill, Gunnell Hill, Quartz Hill and other hills and all of the Perigo district produce ore, the higher grade of which, i. e., above $18 per ton in value, goes to the smelters and the lower grade to the stamp-amalgamation mills. Of the Russell Gulch district ore, the higher grade, i. e., above $15 per ton in value, goes to the smelters and the lower grade is best treated by concentration.

There have been numerous changes for the better in local mining and metallurgy within the last twenty years. In that period the "Gilpin County concentrating table," a local invention, has superseded the old "hand buddle" introduced from Cornwall, for the concentration of the tailings from the stamp-amalgamation process. Twenty years ago there was no market whatever for the concentrates from the tailings, but for a number of years past such concentrates have been in increasing demand by the smelters. The present rate of yield is one ton of concentrates, averaging $10 per ton in value, to eight tons of crude ore. Thirty years ago the stamp-mill charge, with very imperfect saving of values, was $5 per ton; twenty years ago, with improved saving of values, it was $2.50 per ton; to-day the charge is

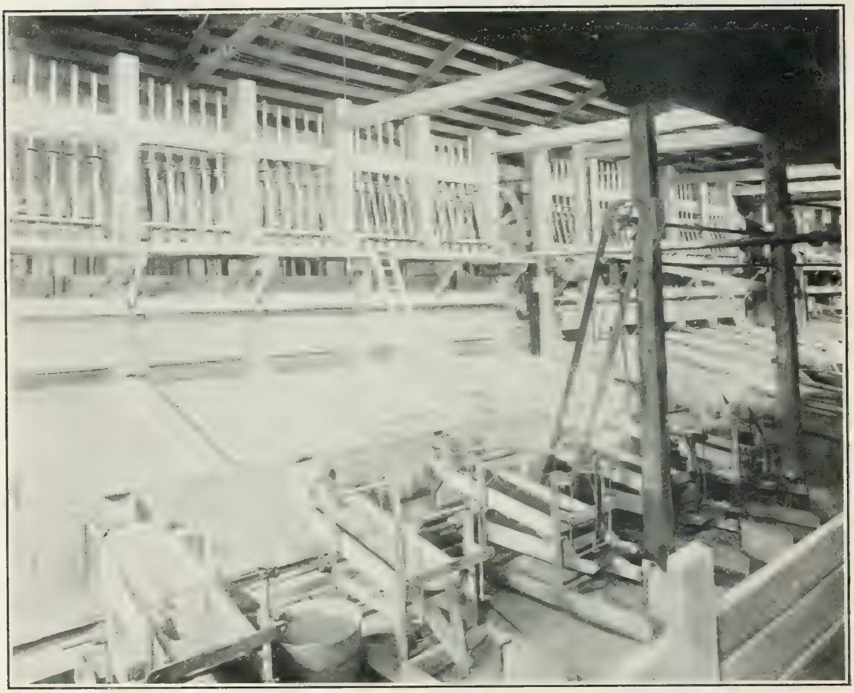
$1.25 per ton, the saving of values being about 80 per cent., viz., 70 per cent. on the plates and 10 per cent. on the concentrating tables. Thirty years ago the smelting charge was $35 per ton and upwards; twenty years ago it had been reduced to $20 per ton; to-day it ranges from $7 to $12 per ton, on smelting ore, according to the character of the ore, and $2 per ton on concentrates.

Railroad and wagon freight rates have been reduced at least one-third within the last six or seven years and more than 50 per cent. in the last twenty years. The Gilpin County Tramway, with twenty miles of trackage, including the main line and spurs, connects many of the shipping mines with the stamp mills on the North Fork of Clear Creek and also with the Colorado & Southern Railroad, so that mill dirt goes economically from the mine shaft to the mill, and smelting ore from the mine shaft to the smelters at Denver and Pueblo. The Colorado & Southern Railroad some years ago commenced and has since continued a freight rate of 50 cents per ton on low-grade concentrating ore from Black Hawk to the mills near Idaho Springs, Clear Creek County, and from 150 to 300 tons per day of such ore goes either by railroad, or direct by wagon, from Gilpin county to such Clear Creek mills where the water supply is ample.

The metallurgy of Gilpin County has by no means attained finality. For the typical Gilpin County mill dirt the mill men (who virtually monopolize all the local water supply) claim that nothing superior to the ordinary Gilpin County stamp mill and Gilpin County concentrating table has yet been devised, notwithstanding many attempts. On



A GILPIN COUNTY BUMPING TABLE.



TYPICAL STAMP MILL, WITH GILPIN COUNTY BUMPING TABLES.

the other hand, some at least of the mine operators claim that the local mill men are ultra-conservative and comparatively unprogressive, and that some of the newer concentrating tables like the Wilfley, Cammett, and other modern value-saving devices could be locally utilized with advantage. This is met by the question whether the extra saving of values would justify the additional expense. The fact remains that the mill men themselves do not claim an average saving of more than 80 per cent. of the values, though the best local mills, kept in first-class condition and operated by careful and experienced men, treating suitable ores, are said to save as high at 90 per cent. of the values. Other mills, needing repairs and operated in a careless manner, naturally save considerably below the average of values from the custom ores committed to their charge. Up to a few years ago, in consequence of imperfect methods, from 40 to 60 per cent. of the values of the ores locally treated went with the tailings into the creek. The future will certainly see the present average of 20 per cent. loss materially reduced.

The controversy of slow-drop versus rapid-drop also remains unsettled. The drop usual in Gilpin County is from twenty-eight to thirty-two per minute, with high discharge from the mortar, the idea being to keep the pulp in the battery as long as possible, thereby obtaining comparatively complete amalgamation in the battery before the material reaches the plates. One effect of this, however, is to sacrifice the concentrates, as the product is slimed to such an extent that it is more difficult to catch the values on the concentrating tables. In the fast-drop of sixty-five drops and upwards per minute, with low discharge from the mortar, the capacity of the mortar is increased, and while the probabilities of saving by amalgamation are reduced, the saving on the concentrating tables is increased. It is claimed, however, that not only has the concentrate product been increased, but the saving on the plates has been maintained up to the percentage achieved by the slow-drop system. In the slow-drop method, the pulp would pass through a 150-mesh screen, although they only use a 40-mesh screen. In the rapid-drop method, the pulp would pass through less than a 100-mesh screen, although they also use a 40-mesh screen.

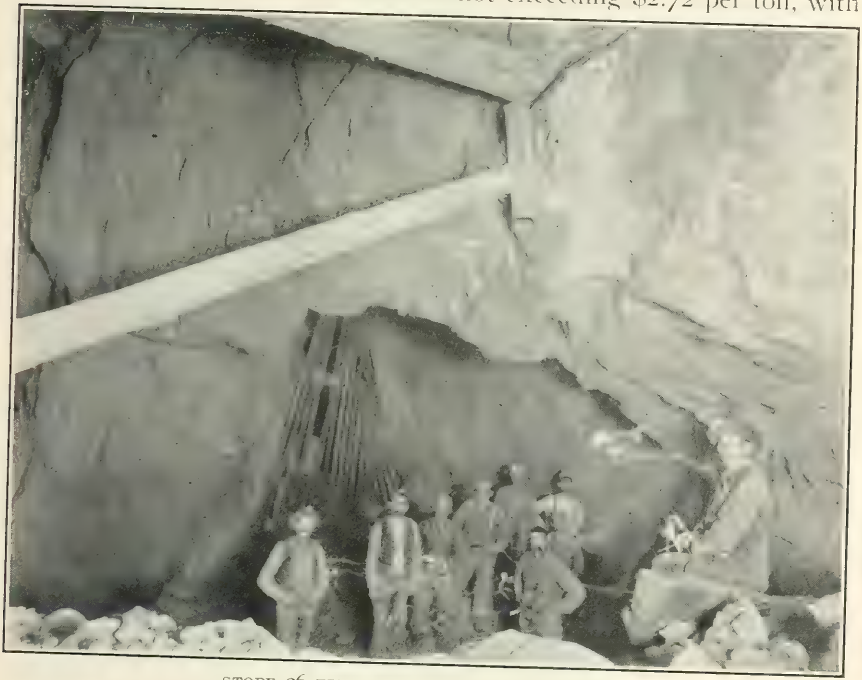
There are naturally gradations in the so-called free-milling sulphide ores of the district. For an ore in which from 70 to 80 per cent. of the values can be saved by amalgamation, the slow-drop system is said to be the best, while where not to exceed from 40 to 50 per cent. of the values can be saved on the plates, the fast-drop is said to be the best, as producing a greater percentage of concentrates and the values are saved on the concentrating tables as well as on the plates.

As to the concentrating ores of the Russell Gulch section, there are immense quantities averaging from $8 to $9 per ton, which regularly concentrate from three to five tons of crude ore into one ton of concentrates, with small loss of value. Such concentrates are in increasing demand at the Denver and Pueblo smelters and will be in great demand at the pyritic smelter just completed at Golden on the line of the Colorado & Southern Railroad only twenty miles below Black Hawk. It is simply a question of a short time when the local output of this concentrating ore witnesses very material increase.

One especial need in Gilpin County is the consolidation of adjoining properties, covering continuations of the same veins, and the effective opening up of such consolidated properties on large scale, looking to the maximum tonnage output at minimum cost per ton. For some years past there has been a decided movement towards the consolidation of adjoining claims (individually too small to admit of operation on business principles) so as not only to adjust conflicting interests and thereby terminate or preclude litigation, but also to admit of the economical operation of the consolidated area through one or more main shafts. Several instances of such consolidation and the advantages thereof are interesting, especially as they best illustrate local conditions.

The Cook-Gregory-Bobtail Consolidation on Gregory and Bobtail Hills now comprises over 10,000 feet, or practically two miles laterally, of the apexes of the historic Gregory, Bobtail, Mammoth, Fisk, Cook and other gold-bearing veins. Prior to such consolidation (the last portion of which was effected in the fall of 1900), the property consisted of eighteen different ownerships, representing a still prior condition of practically hundreds of ownerships. Such segregated properties had numerous more or less obsolete or antiquated shafts and no less than 25 miles of underground workings. It was simply impossible to operate the segregated properties to the best advantage. The past record production of the ground comprised in this consolidation, as shown in the books of the local banks and other authentic sources of information, is upwards of $17,000,000. In December, 1900, Mr. William A. Farish, M. E., the Nestor of his profession in Colorado and the west, after a careful personal examination, estimated the actual ore reserves in the consolidated property, above the present depth of the mines, ascertained from actual surveys and measurements, to be 1,706,793 tons and the additional or probable ore reserves, above the present depth of the mines, i. e., those portions of the veins the value and width of which had not then been determined by the levels, but of which there could be little doubt, to be 1,500,000 tons. Inasmuch as several of the larger veins very nearly come together at one point on the Cook mine, it was decided (prior to the final consolidation) to sink a large three-compartment perpendicular shaft at that point, from which all such veins could be exploited by simply crosscutting to the veins. The Cook shaft is now down 900 feet and will eventually be continued to a total depth of 2,000 feet. At each 100 feet levels will be run on all the different veins. At a depth of 357 feet below the collar, the shaft is intersected by the old Bobtail Tunnel driven many years ago. The ore from below the 357-foot level is hoisted on the cage to the tunnel level, where it is dumped into receiving bins, thence automatically loaded into cars and hauled by electric motor through the tunnel to the stamp mill a mile distant. The electric motor has a capacity of hauling 1,000 tons of ore every 24 hours, at a cost of about four cents per ton. A new mill of 320-tons daily capacity has been erected with eighty 1,000-pound stamps dropping ninety times per minute.

The modern development and equipment installed by the consolidation mean the maximum production at the minimum cost per ton, and consequently the maximum profit per ton. While the larger proportion of the reserves consist of low-grade ore left by former operators, as out of the range of profitable mining and treatment by the then unduly costly methods, such ore reserves, under the new system, can be mined and treated at a total cost not exceeding $2.72 per ton, with probability that it will be done for about $2 per ton, showing a net profit, at a cost of even $2.72 per ton, on the 1,700,000 tons actually in sight, of nearly $4,000,000, to say nothing of the additional probable ore reserves of 1,500,000 tons.



STOPE 26 FEET WIDE IN THE COOK MINE.

This consolidated property, however, is by no means a very low-grade proposition. During the past few years, out of 127,000 tons of ore mined and milled from one portion of the property, the value actually recovered from the ore averaged $8.80 per ton, at a cost, even under the then-existing conditions, not to exceed $5 per ton. Under the improved and more economical methods of operating, at say $2.50 per ton, the margin of profit is materially increased.

The future of this property can scarcely be anticipated. At the present time, the underground workings have attained a depth of nearly 1,000 feet at only two points half-a-mile apart. Having regard to the before-mentioned ore bodies disclosed in the California shaft and Newhouse tunnel at a depth of 2,000 feet, the Cook-Gregory-Bobtail consolidation has below the 1,000 feet level, another 1,000 feet of virgin territory on all its two miles laterally of ore-bearing veins. Mr. Thomas Del Boca, M. E., Paris, France, estimates that with modern methods of mining and metallurgy, the additional 1,000 feet of depth on this consolidation will yield $50,000,000 of profit.

The Gunnell consolidation on Gunnell Hill now comprises 7,000 feet laterally of gold-bearing veins, including 2,350 feet laterally of the famous Gunnell vein. Prior to such consolidation, the property was held in lots of all sizes from 100 feet long and upwards, representing nearly twenty different ownerships and having several dozen shafts, the majority of which were more or less shallow and practically useless. Portions of the property had been the subject of costly litigation, extending over years, but which was finally judicially decided in favor of the immediate predecessors of the present owners. The property now included in the consolidation has a past record production since 1859 of over $6,000,000 and is still practically a virgin property. Under the new consolidation, a system of up-to-date developments, on uniform plan, was inaugurated, on which nearly $100,000 has already been expended, irrespective of current mine expenses. There are now three main working shafts. Included in the Consolidation are stamp-mills on North Clear Creek aggregating over one hundred stamps and a capacity of 4,000 tons per month. The ore in sight in the various properties of the consolidation is estimated at $2,000,000. About 97 per cent. of this ore is mill dirt averaging about $10 per ton, and 3 per cent. is smelting ore averaging in value from $60 to $75 per ton. The mining, hoisting, and pumping bring the ore to the surface at an average cost of $3.25 per ton. It is hauled from the shaft house to the mills, one and one-half miles distant, and reduced, via bullion, into cash at the bank, at a further cost of $1.25 per ton. In other words, the 97 per cent. of mill dirt averaging $10 per ton, is mined, milled, and reduced to actual cash in the bank at 45 per cent. of its gross value, leaving 55 per cent. profit.

The mines and mills of this Consolidation already furnish direct employment to 150 men, although at present development work rather than ore extraction is being pushed. The additional depth of 300 feet now being sunk on the property, viz., from 1,100 feet to 1,400 feet, when opened laterally on all the numerous veins being exploited, will keep the mills of the consolidation running to their full capacity of 4,000 tons per month for six or eight years, without sinking another foot in depth. Within the next two or three years at furthest, the Newhouse tunnel will have reached the territory of this group, cutting the veins at a depth of about 2,000 feet. It is readily seen, therefore, that this consolidation will be producing mineral at a profit for an indefinite number of years to come. No such results as the above were possible so long as the area in question was a mere segregation of nearly twenty different properties.

The Gregory-Buell consolidation is at the foot of the historic Gregory Gulch and comprises what were formerly twelve segregated small properties, having no fewer than fourteen shafts, most of them comparatively shallow, antiquated, and inadequate. The entire property has an aggregate past record production of $2,000,000. Within the area are ten different veins, one vein ranging from 4 to 20 feet wide, a second from 3 to 12 feet wide, a third from 4 to 14 feet wide and the remaining seven veins from 2 feet wide upwards. The group is now being opened up and operated through the Buell shaft, 700 feet deep, equipped so as to have a hoisting capacity of 600 tons per day. The past history of the group shows that at least one-fifteenth of the ore is smelting ore ranging in value from $50 to $300 per ton, the values consisting almost entirely of gold. The other fourteen-fifteenths of the ore is mill dirt ranging from $5 to $25 per ton, with

RUSSELL GULCH, GILPIN COUNTY, COLORADO.

In the foreground the Wautauga mine is on the left, then the Lillian, and on the right the Pollard and Pewabic mills.

THE GILPIN COUNTY TRAMWAY.

a minimum average value of $10 per ton, which it is expected, under the circumstances of this property, can be mined and milled for about $2 per ton. Above the 500-foot level in the various properties of the group, it is estimated that there is $2,000,000 worth of ore already in sight, readily accessible by means of levels and prospects from the Buell shaft. Below the 500-foot level down to the present depth of the shaft, viz., 700 feet, it is virgin ground, as also below the 700-foot level, with probabilities of ore, as shown in the California shaft and Newhouse tunnel in the same mineral belt, to a total depth of over 2,000 feet. The group will have its own stamp mill equipped with Gilpin County concentrating tables, also "sizers" and Wilfley concentrating tables, the object being to accomplish a greater percentage of saving of values than is as yet usual in Gilpin County. By means of such consolidation, admitting of business-like methods and justifying considerable expenditures, this group seems destined to become one of the leading dividend-paying shippers of the district for an indefinite number of years. Without such consolidation, it would necessarily have remained merely a series of isolated dormant properties.

There have been other similar consolidations effected such as the Kansas-Burroughs, representing English capital, and the Ontario-Colorado, representing Canadian capital. There are numerous cases where other similar consolidations might be effected, comprising several thousand feet laterally of known main veins, with several hundred feet in width covering parallel, diagonal, and cross veins; under the management of practical men of local experience, backed by the necessary capital, such consolidations would certainly become regular ore-shipping, dividend-paying properties and considerable employers of labor.

An important factor in the future development and ore production of Gilpin County is the series of tunnels now being driven from the vicinity of Idaho Springs to cut the Gilpin County mines at depth. Idaho Springs on the South Fork of Clear Creek and the Georgetown branch of the Colorado & Southern Railroad has an altitude of 7,543 feet. The mining towns of Russell Gulch and Nevadaville in Gilpin County, but a few miles distant in a direct line from the Georgetown branch of the Colorado & Southern railroad, have an altitude of nearly 9,000 feet, with surrounding hills still higher, covered with mines. It is self-evident, therefore, that the series of tunnels now being driven from along the line of the Georgetown branch of the Colorado & Southern railroad will cut the veins of the mines in Gilpin County at great depths, with the following results:—(1) Such mines will be automatically drained and the serious cost of pumping thereby dispensed with. (2) The ore can be mined at the minimum of cost, the serious expense of hoisting being dispensed with. (3) The ore can be taken from the workings in the mine, in the ordinary mine car, and dumped into a railroad car at the portal of each tunnel. It is not possible at this time to realize fully or to anticipate the great impetus which will be given in the near future to the mining industry of Gilpin County by the completion of these tunnels, one of which,—the Newhouse—has already crossed the boundary line into Gilpin County, is being pushed at the rate of 250 feet per month, and will from now on cut a succession of mineral veins at short intervals.

In view of the above, it is self-evident that the mining industry of Gilpin County, though dating back to 1859, with a production to date of over $100,000,000 of mineral, mostly gold, is as yet only in its infancy. With consolidation of the antiquated, impractical, small holdings into groups of sufficient extent to justify the expenditure of the necessary capital, combined with new enterprise, new capital, and up-to-date mining and metallurgy, the coming forty years will witness a much more phenomenal mineral output, and the end of the period will still find the district not even arrived at its zenith.

AMERICAN MACHINE-SHOP PRACTICE FROM A GERMAN VIEW-POINT.

By Peter Lüders.

In our Editorial Comment in the October number we explained the regrettable occurrence which caused a break of a month in the sequence of Herr Lüder's articles. We are very glad to be able now to present the supplementary and concluding part of his review. It is, in the field of the machine-shop, what Mr. Dawson's leader in this issue is to steam engineering—a comparative measure of international practice and a helpful influence toward internationalising the best practice, wherever that may have originated.—THE EDITORS.

IN a preceding paper, appearing in THE ENGINEERING MAGAZINE for September last, I began this review with the discussion of the deep-lying differences which exist between Germany and the United States in the matter of social and industrial organisation and labour conditions. I left for this concluding paper the examination of the system of specialisation and standardisation as it affects the practical conduct of the works. But to take up the connection between the first part of the paper and the second one, we may first discuss the American draughting room and everything connected therewith.

About the American draughting room and the work done therein two ideas generally prevail—the first, that the draughtsmen work only six or seven hours a day, and the second, that American drawings as a rule are very poor samples of what they really ought to be.

The belief that six or seven hours constitute a day's work in the States is so commonly held, not only in Germany but all over Europe, that a statement to the contrary would find hardly any acceptance. And I must say I myself was quite surprised to be undeceived in this regard, having held before the ordinary belief; and I still do not quite understand why the Americans have given this question so little consideration and failed to change their practice in this particular in accordance with all their other new arrangements. It is impossible to do really good constructing work for eight or more hours a day, especially during the American summer. Certainly no one can run a draughting room on a time-keeping system like a machine shop, brain work being not countable by the hour. But nevertheless some time-keeping-like statistics could be drawn up in regard to the work accomplished in the draughting room and the result thereof would be quite surprising. In Germany there are now some works where the draughtsmen work only from nine o'clock in the morning until three in the afternoon, without dinner time. They are allowed to eat something in the meantime, just as American workmen commonly take some luncheon during working hours, but no one is permitted to leave his work for the purpose. And the statistics of these places have shown clearly that the work done thereat was done with double the pleasure and the interest displayed before, but in half the time only. And I think that to be quite natural, every one of the men feeling that he is treated as a human being and not as a machine. But if the draughtsman is confined the whole day long in the drawing room, he will never find any time to make progressive studies and to increase in this way his capacity of doing good work for his firm. On the contrary, he gradually loses interest in his work, commences to do many things in the draughting room which he ought to do at home, and thus shortens every day his eight office hours more and more without increasing his work.

But all of this affords no sufficient reason for the idea that American drawings for the most part are but very poor approaches to what they really ought to be. I think it would be more natural to conclude that where such a class of work is produced as that which comes from America, there must be first a very good foundation for it, and for the machines surely the drawings form the necessary foundation. This fact, I must say, the Americans have learned to appreciate and have done everything they could to get nothing but the most excellent work out of their draughting rooms. Certainly no one will say that German drawings do not represent first-class work in every way—work of the most painstaking care; but that is by no means the most important point. The main question always must be to get drawings made out in absolute accordance with the general character of the work and its management. Only thus can time, labour, and trouble or useless expense resulting therefrom be saved and prevented, and at the same time real progress be achieved. And I must say the drawings I saw were made with a very close and careful observation of the conditions stated above. They show not a bit more than is necessary, and are thus all very easy to be understood. The original drawings never come down into the shop, but only blue-prints from them. The original drawings, not painted or coloured, nor even inked as is done by the Germans, but nevertheless just as fine work of the most elaborate study and carefulness, are kept up in the draughting room, in a safe or fire-proof drawing storage room. But with the blue-prints they are really not stingy. No workman has ever to run about and to search for a drawing, or to wait till his comrade gets through with a drawing. every one of them having his own. These blue-prints of course are numbered, probably just as they are everywhere else, but generally (as at the Pond Machine-Tool Company) they are also pasted onto a board or a plate of sheet-metal, thus lasting much longer and being always ready for use. A special office takes care of all these blue-prints and there every workman can get every drawing he needs, depositing, as a control, a check giving his own number.

How different are the conditions in some of even the largest German or European works, where even at the present day very often one drawing has to be used by several workmen at a time! There they stand around, disputing as at a meeting all the different meanings and possibilities of meaning not only of the drawing, but of some hundred other things not at all connected therewith. But this is not the only trouble. Very often the drawings do not answer at all the needs of the work, or contain everything else except the latest information. And the reasons therefor are two. The first is one affecting the chief engineer, and is simply that he is overburdened with the details of correspondence: instead of having to do as little writing as possible. thus getting a chance to follow up every improvement made anywhere in his line, he has to divide up his time between his constructions and his correspondence, and unfortunately the first mostly gets the worst of it. The second is that the draughtsman, in a large number of works, hardly gets any chance to see his own constructions really worked out or hears any of the complaints made either by the foremen or the workmen. These complaints are very seldom taken as possibly containing good and useful advice from a real practical man. On the contrary, they are usually counted for nothing, as being made by a man of far lower standing than any engineer ever can have been at. And so I think it would be absolutely impossible to create in Germany or Europe an institution like that, for instance, at the Dayton National Cash Register works, where prizes are given every year for the best improvement or suggestion made by any one of the employees.

Nearly the same thing which has been stated before concerning the co-operation of engineer and workman, will hold true for the factory itself, with all its departments. If the departments do not work together, supplementing one another as much as possible, the work done in the shop will be just as useless as any work done in the draughting room under similar conditions. That again the Americans thoroughly appreciated and so they have built up a complete system to meet all the requirements imposed by these conditions. And just this very system, consisting of the three main parts "standardisation, specialisation and transportation," the other nations come to study. They try to understand it, to adopt it, or simply to copy it.

At first "transportation" seems to have little to do with standardisation and specialisation, but nevertheless it has proved in American works to be just as important as the other two parts, if not even more so. Only with a very carefully arranged system of transportation can the work be made to run as it must, if real success is to be secured. In other words, standardisation and specialisation can be fully carried out only where there is a good system of transportation. Therefore it will be interesting to make at least some study of that system.

The main idea for all the arrangements connected with transportation has been and for the future too will have to be, that no piece whatever shall be handled twice, or backwards, which will be the same as allowing but one direction of movement for every piece under work, the way straight in, straight through, and straight out of the works. Straight in to the main office, to be calculated there and placed under construction as quickly as posssible; straight through all the different shop departments, from one machine tool to another without any useless delay; and at last straight out of the inspection and shipping department. And in that connection, some—if not even yet most, of the American works are model shops, where everything shows that every possible good point in that line has been taken into as careful consideration as possible. For their cranes, for instance, they use as driving power nearly every kind of power obtainable. There are hand, steam, electrical, or air-driven cranes, all running with quick motion in every direction and all, especially, constructed in accordance with the general character of the work they are to be used for. One of the latest constructions of that kind is the pneumatic or air hoist, and hardly anything will be more striking to the European visitor than for instance a modern American foundry, equipped with these cranes. How strange to see the foundry as a large, well-lighted and well-ventilated as well as heated hall, so that even in the hottest or coldest weather it is never an impossibility to work in it, and especially to get the whole year round the regular amount of castings done. Sometimes each one of the moulders, sometimes every two of them, have one hoist for their own. The hoists are travelling ones, connected with a small wheel running on a single track, close to the roof of the building, can easily be moved from one place to another, and are everywhere immediately ready to work with. But it is not only that which makes these hoists so far preferable to any other form used before in any foundry, but particularly their being free from any roughness of motion. When started, the air hoists lift as slowly and as steadily as could be desired, and at the same time can be stopped at any desired height and later on started off again. That fact, together with excellence of construction, has made the standard types of these lifts pretty nearly an absolute necessity for every real competitive modern foundry. I hardly know of any European foundry using this system in the way in which it is applied in some of the leading American foundries. And here may be mentioned still one more not less practical arrangement, in some ways supplementary, at least so far as the general completeness of the equipment is concerned, to the air hoists just mentioned; I mean the overhead tracks or trolleys by which all the metal is carried directly to every one of the moulders, none of it being caught at the cupola, but leaving the moulders, with the exception of a very few, right at their work, thus saving a good deal of trouble, time, and cost.

The cranes and hoists serve simply to handle the goods on the one floor; elevators are used to carry both human beings as well as any material from floor to floor. The works were already arranged so that no workman should lose time searching for a drawing, there being only one place where it could be; now further provision is made that he shall save every minute by taking the elevator instead of climbing up a staircase. Thus the American elevator is no more a luxury but a time-saving machine, just as necessary for every factory as any of the machine-tools, and therefore there is evident just as much care and attention in its construction and its introduction wherever needed in the factory.

But besides the cranes and elevators there are still three other parts of the transportation system, which have to be named as time savers —the bells, the small shop carriages, and the boys. All over the shop push-buttons are installed, and it costs hardly any time for any one of the workmen to reach the next one and to press the button. All the bell circuits come together at the tool room or the general store room, and for every call a boy will come to see what is needed at the place the call came from. In this way for every workman all useless walking about, and stopping here or there for a short talk or anything else, is brought definitely to an end. The boy then goes to ask the foreman to come and see the piece under work, or gets the drawings, the needed tools, or whatever may be required, as quickly as possible, while the high-waged workman still keeps on working, thus saving every minute. Supplementing the bell and the boy are the small three- or four-wheeled carriages, taking away all finished parts, keeping and carrying them from one department to another, until the whole machine, divided up in all its details, is put on there, and the whole load goes to the inspecting and erecting departments, to receive there the very last finish before leaving the work. This system of handling business has for instance shown most profitable results at the Brown & Sharpe works, at Providence, R. I., as well at the Cincinnati Milling Machine Company's works at Cincinnati, Ohio.

So much for the system of transportation, without pretending in any way that there are not a number of other very interesting and noteworthy arrangements in that line not mentioned here, simply on account of lack of space.

Next to transportation, standardisation and specialisation were mentioned as forming the basis of the American system of managing an up-to-date works in an up-to-date manner. But before taking them up in detail, a clear understanding will have to be reached regarding the meaning of the two headings; a misunderstanding of this matter prevails to a great extent nearly all over Europe. The general idea there is, whenever American works in general or American shop management methods especially are called into discussion, that standardisation means simply sticking forever-and-a-day to a single form of construction, once recognized as being a good one. It really means finding out which parts, of as many different machines as possible, can be made in every way alike, thus keeping the cost of production as low as possible. And specialisation is taken to mean simply building only one kind of a machine, may be in a few different sizes, while the true meaning is rather finding out the most simple and at the same time the most perfect way of producing the standard pieces, thus easily defeating in cost and workmanship every possible competitor, who does not believe in nor practice this policy. Thus Europeans have the feeling that the Americans generally are rather to be pitied for being limited—or rather, for having confined themselves—to such a one-sided way of doing business. And the next step to this conclusion, with rare exceptions, will be that if anything is to be avoided, it is this way of stupefying constructors and manufacturers. So they throw the whole system overboard instead of trying first to get a better understanding of the reason the Americans may have for running their works on a system so very much different from the one used anywhere else, and then possibly to adopt at least parts of the system, carefully avoiding everything that could be to any disadvantage to them under general European conditions as between manufacturers and workmen. And so this paper may in its conclusion give in condensed form an outline description of the general layout of an American machine shop, thus showing the system in its most interesting details, leaving it to every one interested therein to adopt for himself what he may believe most profitable to his particular condition.

The system itself certainly depends entirely on the general character of the work to be produced, and must therefore be quite different where on the one hand either heavy or light work may have to be done, and on the other hand where the work will always be of the same kind and character, or where it varies greatly and widely, both in material and construction. But a system will be possible in every one of these works, work being always at least in some sense repetitive so long as flat or round, large or small, pieces have to be worked out, and so long as it will be possible to divide those pieces up in different departments, each department best fitted for its kind of work. And there the Americans are again far in advance, teaching every other nation what it means to figure out these departments with most elaborate care, looking forward both to the best workmanship and the general success of the whole works. But if this department system is really to become as useful and valuable as it has proved and still proves for most American works, every piece of work will have to be taken into a good deal closer consideration, as to its best and cheapest way of production, than is now the custom in most of the factories throughout Europe. No piece whatever can be given to any department, before it has been proved by experiment or experience where it can be produced with the least actual cost—that is, where it can be done with the least depreciation of the machine tool or the tool itself. Besides this, the work must be done in such a way that hardly any special finishing work of any kind will be required. Further, all parts of the same size and make must be absolutely interchangeable, which means finding out where and how to use best jigs and fixtures to the greatest advantage in accuracy as well as in saving of time. Next after choosing the most suitable machine tool, if possible the department best situated in the shop in regard to power transmission or handling will have to be chosen, so as to save in this direction also every possible penny.

If all these points are considered as they ought to be, the planing and milling department will be used nearly entirely for all kinds of flat work, these machines being most adapted to get absolutely true flat surfaces. And there again special care has to be taken in deciding which pieces will best be planed or milled, some firms believing it quite possible, if not necessary, for heavy work as well as for light, to do on the milling machine at least three-fourths of all the work formerly done on the planer. So at Brown & Sharpe's the milling machines are far preferred to the planers, while at other places just the contrary may be noted, or both methods may be equally employed. And as in studying economy of production of the flat parts, all milling and planing work were taken into one department and placed under one inspection, so the round parts are handled together in the boring, chucking, and drilling departments. Sometimes it will be quite possible to combine these three departments, as least as long as mostly only small parts have to be made. In cases where there are mostly heavy parts under construction, the combination will be impossible, simply on account of the general differences in weight and construction, as well as in need of driving power, between the heavy boring and drilling machines and the comparatively light chucking machines. But no matter if the departments are combined into one or not, if good, cheap, and true work is to be produced, it must be stated as a law, that no hole whatever shall be made at any other place of the factory, the right machine tools for all work of this character combined with the right inspection being found only here. And nowhere else will good and careful inspection be as profitable, untrue holes being the most hampering difficulties of all for the erecting and fitting department.

So far we have considered work in which every piece calls for a special workman, and generally a thoroughly skilled one too; or, in other words, work on which one man could run only one machine, and he ought to have a good deal of experience on his machine if his work is to be really good. In these cases automatic machines—that is, the very best time-saving appliances—are of but very little use. But where the general character of the work admits an extensive use of these automatic machines, there must be employed in connection with them the same care and regard for every good point obtainable as is expended upon any of the other machine tools. In this class the turning, the screw-machine, and the gear or rack-cutting departments may be the most interesting and important ones.

The automatic turning machines—by means of automatic lathes mostly—running with fast feeds and taking heavy cuts, are a very good factor of the blacksmith shop, effecting a great saving in coal formerly used in heating up long and thick pieces, and a great reduction as to wages for the blacksmith as well as his helpers, while shortening the time formerly used in useless forging and cutting-off work. The automatic screw machines for making screws, nuts, bolts, pins, studs, and washers, from the smallest up to the largest ever needed, are one of the most ingenious machine-tools ever constructed. These machines have done away with a very great part of the expensive fitting, filing, and polishing work, besides rendering one man able to run several machines at a time and every one to its full capacity if necessary.

The automatic gear- and rack-cutting machines are quite different, but by no means less interesting or less useful machines. While the others only effected a saving of time and work in the machine shop, these automatic gear-cutting machines have made the original foundry work a great deal simpler, easier, and cheaper. No gear or rack should ever be cast any more or should be cut otherwise than out of the full material by the use of the very best automatic machine tool especially constructed therefor, thus getting absolutely accurate and perfect-running gears, which is equivalent in many cases to a great diminution in general depreciation as well as in driving power required.

Next to these last three departments, mentioned as being absolutely necessary for the production of all kinds of round parts, the automatic turret machines must be named. These machines are automatic also, at least in the sense that a fixed number of operations can be performed without need of especially replacing a separate tool for each operation. Some of these machines enable the production of work at half the cost incurred before on a common lathe, etc., avoiding all the tiresome setting-up work and rendering it nearly impossible to get out other than absolutely interchangeable work.

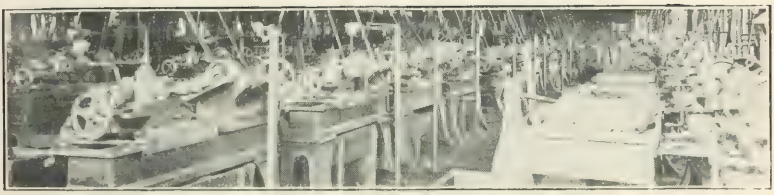
As an addition to the departments listed above must be noted the scraping, grinding, and polishing department. All these give the last finish to the work commenced at one of the other places, and are an entirely American machine-shop feature.

The scraping work is done entirely by hand and requires a number of special tools and a good deal of practise, if true surfaces are to be obtained and all useless fitting work practically avoided. Where absolutely round parts or true holes are required, the grinding and polishing machines, as for instance those of the Brown & Sharpe Company, are by far the best machines of their kind. The results gained with these machines, first only on smaller parts, brought it about by and by that in some cases even the largest pieces were put on them, as for instance such work as grinding the journals of the largest axles, as I saw done at the Southwark foundry.

Lastly may be enumerated some departments which will be very useful and profitable in cheapening and likewise increasing and controlling the yearly output of a large modern factory, while not absolutely necessary for a smaller but still equally well managed firm. These are the assembling department for large or small parts, together with the very important, but in Europe unfortunately so very often quite neglected, storage room for finished parts as well as for those under work, if possible or necessary. Next, the cutting off and centering, combined with the hardening, tempering, and annealing department, serving to prevent on the one hand useless carrying about of the stock material, and on the other hand to send only best prepared parts out to the different departments. Last, but practically the most important department mentioned, is the laboratory. It is quite surprising to observe how long a time it took for even the most intelligent machine-shop managers to get an understanding of the enormous importance of such an institution as a well organised laboratory. The first steps in this direction are made now for instance at the Midvale Steel Company, at the Niles Tool Works Company, and at a few others of the largest firms. But it will take still a considerable time before these laboratories and their followers will be in a state to be a real help to the machine shop, and the figures obtained therein will actually form the basis for conclusions which should be drawn as to the character of the material to be worked on before ordering any machine tool. It may be that through their work a far better understanding will be arrived at on both sides of the Ocean as to the requirements of the builder, as well as the customer, in regard to the construction and the advisability of the different machine tools.

Before concluding this paper it must be said that as all items mentioned have of necessity been briefly treated, some others have not been mentioned at all, simply on account of being by far too important to be dealt with at the same time. So in many cases the success of the whole works depends not least on the foundry and its management. and just therein the European machine-tool builder as well as every foundry-man can learn a great deal from America how to run a modern and competitive foundry. Further, I have left out of consideration the real soul of every works—the entire accounting and cost-keeping system.

The conclusion of the paper then may be reached with a warning to the Americans as to the way they educate their boys right in the works. To-day there is a boundless need of planer or lathe hands, and with the automatic machines nearly anybody can do the work formerly done only by a "thoroughly skilled man." So it has become quite common to use the boys first only as shop messenger boys, keeping them trotting about the whole day long without giving them any chance to do even the simplest work of a helper. Later on one of the planer hands takes hold of one of the clever ones and puts him on his job as his helper, but unfortunately never sending him out again, sending him down to the erecting floor, or giving him some lathe work to be done. So the boy becomes again a planer hand and calls himself pretty soon a skilled one, while he actually has no skill at all. The end thereof will be that the skilled men will get more and more rare, while the so-called skilled ones will be in abundance. But at the same time all progress will be stopped, only the thoroughly skilled man being able to give good suggestions for real improvement on the machine-tool he is operating. And if these suggestions cease to be made, the engineer will lose the very best help for progressive work on his part, and so finally the model shop and the automatic machine will bring death to their users, instead of pulsating life.



THEORY AND PRACTICE OF ESTABLISHMENT CHARGES.

By A. Hamilton Church.

V.—FACTORY AND MASS PRODUCTION AND THE NEW MACHINE RATE.

Mr. Church's first article, which appeared in our July issue, dealt with the vital necessity of accurate cost keeping. His second paper analysed the chief accepted methods of apportioning general expense to individual jobs and pointed out their deficiences, and in the third article he developed a comprehensive and accurate system. His fourth paper discussed the classification and dissection of general expense. The concluding number of the series next month will review the entire field of establishment charges.—The Editors.

HITHERTO the case of an ordinary engineering shop has been under discussion, in which each production centre is in charge of an operator, whose wages form a separate item of cost. We have now to regard the case of factory production, in which it may not be profitable or necessary always to be taking out cost, because there is here not so much a question of separate jobs each different from the other, as of batches or lots of similar or closely similar articles going through time after time without variety in pattern.

It is also in connection with this class of work that we usually meet the automatic or nearly automatic machine, which introduces new difficulties into the question of costing, if not of shop charges. Take for instance the case of a group of small turret machines making some particular piece, for which the call is not absolutely constant. We will assume that there are five machines in the group, under the charge of one man, who sets tools and attends to all the wants of the process. Some of the machines are always running, but the number varies from, say, three to the full five. What is the cost of the work under these varying circumstances and what the proper incidence of shop charges?

The usual plan of taking out prime cost by means of time sheets evidently fails here, since this would lead to the same job being charged with 1/3 of the man's time today when he was working three machines and with only 1/5 tomorrow when all five happened to be working. It is evident that this result is worthless for any practical purpose. And when it is considered that different articles may be running on each of the five machines, or three alike and two separate, or indeed any possible combination of five numbers, the confusion is still worse. The costs become quite meaningless.

Not so however with the new machine rate. As far as any particular job is concerned it is a matter of indifference if one, two, or all the five machines are in operation simultaneously. Whatever work is done receives its due debit of charges strictly in proportion to the time it takes. It is not even necessary that all the machines be exactly alike. One of the five may be a larger machine with a correspondingly higher rent charge. This matters nothing; just so much work as is done is burdened with its own proportion of machine rate, and therefore with its share of shop charges, quite irrespective of whether the other four are idle or working. As has already been explained, the idle time on each machine falls into the supplementary rate.

It matters not, therefore, from the point of view of the distribution of shop charges through the new machine rate, whether the machines are automatic or not. An automatic machine is still responsible for rent, interest, floor burden, cost of power, working expenses for oil, or other process supplies, just as an ordinary hand-operated machine is. And there is no difference in the method of determining these charges. If a hand machine were to be made automatic it would not alter the rate, except in so far as the alteration might have happened to alter some of the factors. If these were not altered at all, then the rate would also be unaltered.

But this does not get over the difficulty of the direct wages allocation. The prime cost is complicated by the change undoubtedly. Every machine, however automatic, does unquestionably take up some part of a man's time, and the important point for cost-account purposes is to know what is the usual amount of time so taken up. In the case of a small automatic hack-saw, where the time occupied in changes is inconsiderable relative to the length of the process, no substantial injustice would be done by neglecting the wages factor altogether. But though this might answer in the case of an isolated machine, it certainly would not be fair where several machines are in question; and where the automatic machine is in the direct line of the process-work it is evident that the wages difficulty must be solved.

The plan advocated here involves perhaps considerable breaking away from traditions. Briefly speaking, it is proposed in the case of automatic machines to consider wages of attendance as a factor of the new machine rate, based on the *maximum number of machines that can be worked simultaneously under the most favourable conditions.*

If, for example, we have a group of five automatic machines, capable of being operated simultaneously by one man, at $10 per week, we consider the proper labour charge per machine per week to be $2, which is equivalent to an hourly rate of 4 cents for each machine. This 4 cents is added to and made part of the new machine rate in each case. It follows, of course, from this that if one or more of the machines are idle, the unallotted wages fall into the supplementary rate along with other shop charges.

The plan of treating the wages on automatic machines as one element in the shop charges, and therefore suppressing their separate existence as an element of prime cost, is justifiable on several grounds. Whether machines are working or idle is a matter of general shop economy, varying according to the commercial situation or the efficiency of organisation. Now, within very wide limits where groups of automatic machines are concerned, it is fairly evident that under conditions of varying commercial efficiency, the number of machines in operation at any one time will vary from day to day, but not the wages bill. Therefore we shall not be far wrong in assuming that the adverse conditions due to slackness are more properly thrown upon the supplementary rate than visited upon the individual jobs. It has just been shown that the wages factor is one of the most variable elements in connection with a group of automatic machines. When all machines are working full time and things are at their condition of maximum efficiency, each job in the case of the five machines mentioned above is receiving a debit of 1/5 of the attendant's wages. When only three of the machines are working, each job done on those machines still continues on the new plan to receive 1/5, and,as will readily be understood, the remaining 2/5 falls into the supplementary rate.

The practical advantages of this are: (1), The prime cost, being wholly composed of the machine rate which includes the wages factor, remains the same under all conditions of shop efficiency; and, (2), the unappropriated charges, including of course the balance of unallotted wages, instead of being visited on jobs which do not deserve to suffer, go to swell the supplementary rate which is, as before explained, an index to the conditions of shop efficiency.

In the case of mixed shops where groups of automatic machines are ranged alongside hand-operated machines, some little care must be taken in arranging the wages factor as a component of the new machine rate. The wages of each operator must in the mixed shop be divided over such machines only as he is in the habit of working. It will be evident that should a man at a different rate of wages be put permanently on the machines, the machine rate will have to be altered; but in the case of a temporary substitution due to shop exigencies this should not be done. Any difference will be a matter of temporary accommodation, properly thrown onto the supplementary rate.

In the case of a shop given up entirely to factory production proper, such for instance as a grinding or polishing room, the advantages of the proposed method become still more obvious. After the ordinary machine-rate factors have been determined, a carefully estimated average wage rate is added on to the machine rate, and becomes part of it. Now such average wages rate is based, as before explained, upon the largest number of machines that can be worked by any one operator, or in cases where an operator has assistants such wages are added together and then averaged. In any such shop it frequently happens that workers are graded rather by length of service than by competence. The averaging plan gets rid of these anomalies. Where differences in wages are not due to differences in work, it is most desirable that the costs should not vary because a higher- or lower-waged operative has happened to be employed on any job.

In all these cases, the wages of operators which have been reduced to machine-rate factors are debited at the end of the month to the shop account. As this account is credited with all the machine earnings, it follows again that the balance of time not occupied to the utmost efficiency (as for instance in the case of three only out of five machines being worked) remains uncredited and thus is left to be dealt with in the supplementary rate.

The main point of difference between the new and former method may be briefly summarised. In the case of automatic machines, or of regular factory production, the wages of operators are treated as a shop charge, and a factor is added into the new machine rate by which such wages are charged to jobs on the basis of conditions of highest efficiency. A departure from these highest conditions does not reflect itself in the No. 1 cost of the job, but only in a higher supplementary rate distributed as a general shop charge by hourly burden.

When all the machines are running, and consequently the conditions of maximum efficiency are fulfilled, there will be nothing left in the shop account but the really general shop charges, such as general foremen's wages, and consequently the effect will then be the same as if the wages of each operator were being distributed by time sheets over the jobs he is actually engaged upon.

The principle might be illustrated by saying that each machine is looked on as having a little bit of its operator's wages permanently attached to it. When the machine is working this fragment of wages is transferred to the jobs done, but if it is idle the fragment is transferred to the general shop expenses, and is distributed over the work generally as supplementary expenditure.

Reference has been made to regular factory operations which do not need that costs be continuously taken out. Where machines are constantly employed on the same article, or process, say slitting steel pens, it is not usually considered necessary to keep a regular record of production. Particular days are selected and the output of the machine for that day is taken. This, divided by the number of hours and multiplied by the machine rate, gives the No. 1 cost for the product, plus, of course, the number of hours multiplied by the supplementary rate (hourly burden) if No. 2 or shop cost is required. This being done from time to time is frequently considered to be sufficient check to ensure proper working. Whether it is really so or not will depend largely on circumstances, obviously.

In any case, to work out the figures required at the month end it is necessary to keep for each machine a machine time table, showing the hours during which it has been working. This is summarised at the month end, and the total month's earnings of the machine credited to the shop account. It makes no difference whether the costs per job or per batch are worked out or left unextended. As long as we know the numbers of hours worked, the supplementary rate can be found, and thus the true shop cost of any job, whether all the jobs are costed out, or only selected ones. By using a special form of machine time table, and by sending through the work in regular batches of say, 10,000 pieces, distinguishing each batch by a letter as, A, B, C, ... Y, Z, etc., both these requirements can be met at once, and the cost of each batch recorded, even though it is only occasionally collected together in the regular form of a cost account. This can, of course, be done at leisure, without special arrangements. In many respects this is an advantage over the occasional watching of outputs, since these tests nearly always become known and can thus be manipulated by a cunning operator.

Space does not permit in this series of articles of more than the outlines of the method being developed; the presentation of actual forms and accounts both for inaugurating and working the system must be left to another occasion. But as concrete figures and examples

SHOP-CHARGES ACCOUNT, JANUARY.

Debit		*Credit*	
To Interest on machines.....	$53.00	By	
" Depreciation on machines.	53.00	Machine earnings.........	$576.00
" Power......	100.00	Being total of amount distributed to jobs by means of new machine rates this month. See Table A of "Machine Time Made," below.	
" Wages on auto machines . (2 operators and overlooker)	75.00	Undistributed balance,	100.00
" Process sundries (oil, etc.)	45.00	(Supplementary rate = this amount ÷ hours worked, *i. e.*, $\frac{\$100}{4,400} = \$0.0227$ per hour.)	
" Debit for floor burden. 5,000 sq. ft. @ 5 cents.	250.00		
" Supervision (general). .	100.00		
Total debit,	$676.00		$676.00

Total hours made as per Table A. = 4,400.

Supplementary rate this month = 2.27 cents per hour.

N. B.—The hourly burden for this shop on the ordinary average hourly burden plan would work out at $\frac{\$676}{4,400 \text{ hrs.}} = 1.54$ cents.

TABLE A—SHOWING MACHINE TIME MADE. MACHINE EARNINGS IN JANUARY.

No of Machine.	Total Hours Worked in Month.	(New) Machine Rate Per Hour	Earnings—i e. Amts. Debited to Jobs thro. M. R't	Remarks.
		Cents	$	
1...........	200	4	8	Hand-operated machines. Wages allocated direct to job per time sheet.
2.......	200	7	14	
3............	200	23	46	
4	200	25	50	
5....	200	12	24	
6	200	10	20	
7	200	09	18	
8	200	34	68	
9....	200	04	8	
10....	200	16	32	
11	200	9	18	Group 1. Auto machines. Wages part of machine rate.
12....	200	9	18	
13....	200	9	18	
14....	200	9	18	
15	200	9	18	
16.... ...	200	9	18	
17...........	200	15	30	Group 2. Auto machines. Wages part of machine rate.
18	200	15	30	
19	200	15	30	
20...........	200	15	30	
21	200	15	30	
22	200	15	30	
TOTALS. .	4,400	....	$576.00	....

give a very much clearer idea of what is actually effected by the system than any amount of merely verbal argument or description, the remainder of this article will be devoted to the presentation of an actual set of results. They relate to a shop in which many of the machines are worked by single operators, their time being booked direct to the job in the usual way. There are also two groups of six automatic machines, each group requiring an operator, and the two groups are in charge of a special overlooker.

The shop and cost accounts are presented, first, during a period in which the shops were full of work, and secondly, some months later when trade was very quiet. The same job is given under the two conditions, and is also shown separately in the second period, as an improvement in the method of manufacture was made at this time.

COST STATEMENT OF JOB (JANUARY).

10 Hours machine No. 9 @ 4 cents per hour		$0.40
6 " " " 8 @ 34 " " "		2.04
12 " " " 17 @ 15 " " "		1.80
3 " " " 3 @ 23 " " "		69
Add. Total machine rates,		$4.93
Supplementary rate @ 2.27 cents per hour on 31 hours,		.70
Total shop charges,		$5.63
10 Hours' wages @ 31 cents per hour	$3.10	
6 " " @ 10 " " "	.60	
3 " " @ 14 " " "	.42	
Total wages,		$4.12
Total No. 2 or works cost of job,		$9.75

It will be noticed that in this month all the machines made full time; consequently the supplementary rate was very low, viz., 2¼ cents per hour. The contrast between the average hourly-burden plan figure, viz., 15 cents per hour, and the new method, is very well seen by a glance at the Table A of machines. We have here machines which are rated as high as 34 cents per hour, whilst others are as low as 4 cents, this latter machine being a watchmakers' lathe, operated by a highly paid man. These differences in the incidence of shop charges being based on real figures, it is obvious that the new method offers an important advantage in differentiating such different charges as 4 and 34 cents per hour, in place of averaging them all round, as the hourly-burden plan does, on a basis of 15 cents.

SHOP-CHARGES ACCOUNT (November).

Debit.		*Credit.*	
To Interest on machine	$ 53.00	By Machine earnings As Table A.	$292.53
" Depreciation on machine	53.00	" Supplementary rate	305.47
" Power	62.00	$\frac{\$305.47}{\text{Hrs } 2{,}187} = 14$ cents per hour.	
" Wages on auto machines (1 operator and overlooker).	55.00		
" Process sundries (oil, etc.)	25.00		
" Debit for floor burden	250.00		
" Supervision	100.00		
	$598.00		$598.00

Total hours made as Table A = 2,187. Supplementary rate this month = 14 cents per hour. Average hourly burden on hourly-burden plan would be $\frac{598}{2,187}$ = 27.3 cents per hour

TABLE A.—SHOWING MACHINE TIME MADE AND MACHINE EARNINGS IN NOVEMBER.

No. of Machine.	Total hours worked in month.	(New) Machine rate per hour.	"Earnings"—i. e., Amounts debited to jobs per machine rates.	Remarks.
1	130	4 cents.	$5.20	
2	125	7 cents.	8.75	
3	86	23 cents.	19.78	
4	140	25 cents.	35.00	
5	200	12 cents.	24.00	
6	200	10 cents.	20.00	
7	200	9 cents.	18.00	
8	90	34 cents.	30.60	
9	200	4 cents.	8.00	
0	80	16 cents.	12.80	
11	....	....	....	This group was idle and operator stopped.
12	....	....	....	
13	....	....	....	
14	....	....	....	
15	....	....	....	
16	....	....	....	
17	140	15 cents.	21.00	
18	80	15 cents.	12.00	
19	96	15 cents.	14.40	
20	140	15 cents.	21.00	
21	140	15 cents.	21.00	
22	140	15 cents.	21.00	
Totals	2187		$292.53	

COST STATEMENT OF SAME JOB (November).

31 hours' machine time (details as before)	$4.93
Supplementary rate, 31 hours at 14 cents	4.34
Total shop charges	$9.27
19 hours' wages (details as before)	4.12
Total No. 2 or works cost of job	$13.39

In the cost statement it will be noticed that only three items of wages figure, although there are four machines concerned; this is because machine No. 17 is one of the automatic machines, and the cost of operating this is charged through the machine rate, as previously explained in this article. When we come to contrast this job-cost statement with that for the same job in slack times, the further advantages of the method will be seen.

The month of November was a very bad one, the factory was working barely half time. Yet, naturally, the debits against the shop were not reduced in anything like the same proportion. There was in consequence a sharp rise in the ratio of charges to work.

The effect of this can be seen in the cost statement of the job. The works cost of this has gone up from $9.75 to $13.39, although precisely the same machine time and the same amount of wages was expended in the one period as in the other. A glance at the statement tells us, however, that the increased cost is wholly comprised in the one item of supplementary rate, and was not due, therefore to removable causes as far as this job is concerned.

Now on any average distribution plan, whether by percentage on wages or by averaged hourly burden, this information would be lacking. We should see merely that the debit for expenses against that particular job, and its works cost, was higher; but *why* this was so, whether due to variation in process or wholly to increase in the ratio of charges, would not be ascertainable without considerable investigation and analysis. Here, on the contrary, it is seen at once that the debit for machine time—viz., $4.93—is the same as usual, thus allowing us to compare the debits due to variation of process at different periods, quite irrespective of whether the shop is busy or slack.

Apart from the greater precision and accuracy of the method, this disentanglement of the charges for work done from the charges due to slackness is a very considerable gain. It is, in fact, a step nearer the true representation in the accounts of what has actually happened in the shops. By bringing out all natural differences to the full instead of averaging them all down, we obtain a stronger grasp of the situation.

In the following statement the cost of this job for November has come out at $11.35 instead of $13.39. The difference is due to an improvement in method of working. The important point is that neither the wages nor the hours taken have varied; therefore on any averaging system, whether on wages or by hourly burden, this improvement would be absolutely lost sight of, inasmuch as neither of the factors on which they rest has happened to vary.

COST STATEMENT OF JOB.

PUT THROUGH IN NOVEMBER, BUT ON AN IMPROVED METHOD.

10 hours No. 9 @ 4 cents per hour		$0.40
* 6 hours No. 2 @ 7 cents per hour		.42
12 hours No. 17 @ 15 cents per hour		1.80
* 3 hours No. 7 @ 9 cents per hour		.27
Total machine rate,		$2.89
Add supplementary rate 31 hours @ 14 cents per hour		4.34
Total shop charges,		$7.23
10 hours' wages @ 31 cents	$3.10	
6 hours' wages @ 10 cents	.60	
3 hours' wages @ 14 cents	.42	
Total wages (same as before),		$4.12
Total No. 2 or works cost,		$11.35

* Altered process. Compare with former statements.

But a glance at the job in the form presented here is sufficient to show what has happened. Wages are the same, supplementary rate is the same, but the debit for machine rate is less. This leads us at once to the nature of the change, which has resulted in an economy. It is that in two cases, a less heavily rated class of machine has been substituted for those in use before. Machines at 7 and 9 cents per hour have superseded machines at 34 and 23 cents per hour.

On no method but a machine-rate method can differences of this important class be made visible, and no machine-rate method is in itself complete or advisable, unless accompanied by the device of the supplementary rate to absorb and deal with the idle time. But with these combined the resulting method is not only more accurate, but fulfills functions which are entirely missed in other methods.

In the next article, (which will conclude this series,) the question of general establishment charges, i.e., those due to the selling organisation, will be dealt with, and some remarks will be offered on the proper uses and digestion of costs and establishment-charge accounts.

THE ENGINEERING MANAGEMENT OF INDUSTRIAL WORKS.

By William D. Ennis.

The vast material progress of the last half century has been the direct result of entrusting more and more of the executive management of enterprises to the engineer. The man scientifically learned and practically trained in the utilisation of forces and the handling of materials has assumed his reasonable and proper place in organisation and direction, as well as in design and construction. Mr. Ennis shows on how sound a basis of common sense this policy is founded, and argues ably for its extension on purely economic grounds.—The Editors.

THE supreme control of industrial enterprises, including the general management of all phases from the purchase of supplies to the sale and delivery of finished product, is classically in the hands of the expert accountant. The line of promotion in the past has been usually from the book-keeper's desk toward the higher chairs. An innovation was practised, when, instead of the clerk, the private secretary, or stenographer of higher degree, who of all others had opportunities to become familiar with the motives and methods of his chief, was marked as the legitimate successor of that chief.

A still more marked innovation has lately been evident. The managers of to-day are technicists. Engineers—mechanical and civil—make it their ambition to become, not consulting experts, but executives. Among military and naval cadets, the most brilliant and successful students eagerly enter the engineering corps of the service, and become in after years the most thorough and successful officers. The same tendency is pervading commercial life. To refer to a single one of the older American engineering colleges as an example—the Stevens Institute of Technology, in New Jersey, founded in 1872 by an engineer: of the 600 graduates prior to 1896, 230 (or 38 per cent.), were in 1900 occupying positions not technical but executive. The functions of many others who fill nominally professional offices are in reality purely those of management. The chief engineer of a large manufacturing company often becomes as little of an engineer (excepting in his methods) as his typewriter.

This state of affairs is becoming more and more prevalent. The managers of street railway, gas, electric-lighting, and similar companies are, in the main, men of engineering training. The general management of broader manufacturing industries is being concentrated in the same direction. The departmental organization of commerce requires men who shall be, first of all, able executives—second, experts in the departmental work. In all excepting purely specialized branches—such as the legal or financial—use is being made of the trained engineer. Salesmen of mechanical goods, railway transportation-department officials, and incumbents of many other apparently unrelated fields, are made from engineering timber. The highest executive positions in the great industries are accessible to men of mechanical training and common sense.

The United States are confronted with an era of industrial consolidation, of which we have thus far seen but the inception. A line of succession must sooner or later be established, leading to the posts of responsibility. These consolidations may properly be viewed as just so much labor-saving machinery which, like similar developments of the past, have met with much unintelligent condemnation, and which have been rendered possible to no small extent, because of specialized engineering talent.

Much of this is due to the almost invariable consequences of engineering training. It gives thoroughness first of all, for no progress is possible in mechanical operations without thorough mastery of each step. It gives a command of details. It develops a graphic habit of thought, an ability to picture abstract things, and to make mere conceptions real. It emphasizes the necessity of recording, transcribing, comparing, and perfecting one's observations until the elementary facts have been clearly sifted out and the basic principles mastered. And at no stage, especially if coupled with rational and competent scientific study, is it other than broadening to every faculty of the mind. More than all these, it creates the courage and ability to grapple with new conditions with a confidence born of a thorough understanding of the natural laws involved, that unerringly define, limit, and control even uninvestigated phenomena.

The fundamental engineering concept is that of efficiency—the quotient of work performed by work imparted, of value by cost, of effect by cause. This concept is fundamental, not in engineering alone, but in every phase of business management. A cost-keeping system may be never so accurate, but if it stops short at dollars and cents on record, it lacks life. Beyond this point—where the analysis is of value only as a comparison—there is the question of what each particular cost *should* be, or the question of a theoretical efficiency toward which experimental efficiencies must constantly approach. It is not sufficient to insist that costs shall bear a constant ratio to output. The ratio under ideal conditions must be determined by calculation, and should be gradually but steadily approached in practice by bringing about conditions resembling ideal ones. With a few conspicuous exceptions, neither the expert accountant nor the stenographer is qualified by his training to perform such calculations.

In the broadest sense, the efficiency of a manufacturing industry is equal to its receipts divided by its expenses. This industrial efficiency is, however, the product of the several efficiencies of the departments in entire production, in each of which there must be struck a balance between commodities furnished to and by it. With each department normal, the combined efficiency is normal; and an abnormal condition of things shown by the sum total can only be satisfactorily analyzed by one who can apply the touchstone of his own training and experience to the offending element.

The three processes,—consumption, manufacture, disposition of product,—form two gaps for loss. Incompetent superintendence of plant makes the first element high, unintelligent sales keep the third element low, both in proportion to the second. To reduce both losses to normal (when that normal has once been ascertained) there must be quantitative knowledge of the operation of all three departments. This knowledge must consider not only the bulk of commodities in each, but their cost or value as well. The former data—consumption of raw materials in pounds or feet, product in units of weight or measure, sales in gross—furnish a key to the efficiency of the department chief, the superintendent, and the salesman, respectively; but the cost of raw materials, the value of product, the profits on sales, are the measure of the individual competence of the purchasing agent, the manager, and the capitalist. Into the problem enter at least six factors of personal efficiency.

One of the first lessons in engineering training is that of continuity of records. The operation and economy of machinery must be measured from day to day—sometimes from hour to hour. Wastes must be anticipated, and prevented rather than cured. Possible economies must be perceived sufficiently in advance to permit of making the proper preparations to realize them. No possible training could be more typical of what is required from an executive head.

The cost clerk discovers these things only after they have passed into history. His lessons are learned too late. If the engineer or superintendent is pre-eminently obtuse, the cost clerk may be able to tell him things that he has himself overlooked; but the average competent man of the former class will have gone all through the battle and have gained his experience before the figures reach the office.

He learns, as well, the tangible value of an experiment or a test. It may be worth a considerable loss merely to know and recognize the conditions which make for such loss.

In every industry, there must be an ability to retain a constant record of, and acquaintance with, the variations in efficiency. The yearly balance sheet is not sufficient. The economy of the plant must be known for each month, each week, and each day. This knowledge must include the consumption, production, and disposition, in units of quantity and of value. The working day should not close without a calculation of what the record of that day has been, in every department. It is never impossible to obtain the data for such knowledge, although at times it may be expensive and a matter of some complication to do so. The system, if one of approximation, must be fair, so that consumption of raw materials can be apportioned pro rata with output without injustice. It must be reasonably accurate, so as to agree with monthly cost statements; it must express and weigh all conditions affecting the data obtained.

For comprehensiveness, simplicity, and accessibility, columns of figures cannot compare with graphic charts, such as the engineer uses in recording his experiments. These are sheets of ruled paper on which a small circle may be marked to represent the figure, in units of quantity or value, for the day. The horizontal intervals of the chart represent intervals of time, the vertical distances indicate amounts. The circles are joined by straight lines, forming a broken thread which offers at a glance a detailed history of the fluctuations of each item for the month or year as the size of the chart may permit. Such a diagram is familiar to every engineer; but its value to him, while great, is small in proportion to that which it may possess, under intelligent adaptation, to the man who must know quickly and accurately the entire structure and conduct of his business.

The engineer is taught to maintain and resort to his note book. Into this go his observations, experiments, rules, tables, and data. It grows in value from year to year. He finds in it records that save him useless experimentation and prolonged investigation of once-tried suggestions. The executive, too, must have his note-book, perhaps a thousand times more expensive, possibly less convenient. It may take the various forms of card indices, portfolios, scrap-books, or filing cases; but if used as the engineer uses his records, it will save time and money. It will prevent simultaneous or repetitional empiricism in all the lines of industry under control. New methods and systems of production, new grades of material, new schemes of extension, new policies and announcements, can first of all pass inspection in the light of this collection of facts.

The most elaborate command of details is weak without rational classification. All the factors in the three assumed departments must be grouped with regard to quantity, cost or value, relations with other commodities, and relations to totals. Revenue or expense must be credited or charged to the proper department, especially where there is an interchange of departmental services. Extraordinary revenue or expense (all outside of the purchase of supplies and the sale of product) should be justified by complete analytical figures and data, showing the causes and consequences, not only for memorandum, but as a possible factor in affecting the value of the plant and good will as an asset in trade.

These methods of successful management are not dependent upon unusual talents or abilities, but rather upon high and rigidly-adhered-to ideals of conduct and usefulness. They involve a patience with and command of details; the ability to grasp salient points, to analyze and classify data; readiness for emergencies and unfamiliar conditions; a progressive spirit; resourcefulness, of self and in subordinates; and, more than all, the faculty (and desire) to use men of ability by gaining their interest and co-operation, and, having ascertained their most efficient field, by trusting them without interference.

As an employer of labor, the engineer takes neither the cold and heartless attitude of the old-school manufacturers, nor the more modern and sometimes (on paper at least) excessive altruism of the theorist. He looks upon these subjects with common sense. To him, his subordinates are human, and interest him. He is frank and courteous among them, but he measures their value, in the ultimate, as he would that of a steam engine, by their efficiency. If they fail to meet that test, his duty impels him to see that they step down and out for more efficient and deserving men who will add to the sum total of human wealth and happiness instead of decreasing it. He readily learns, and never forgets, to separate his business wholly from all relations—social or otherwise—that interfere with or hamper him in, its conduct.

One of the most striking of recent industrial developments is that of the interchange of information. In this, the engineer has been a leader. For many years his societies and institutes have formed meeting places for men who, while possibly keen competitors in commercial life, have yet found it to their mutual advantage to exchange views, records, and opinions. No other profession has been so quick to overcome personal and selfish motives in this respect. Manufacturing companies are beginning to share the same blessing. For many years, allied interests, those whose directorate to a large extent may have been identical, have exchanged information regarding common problems. In the United States, the Edison electric illuminating companies have long maintained a society for the specific purpose of effecting such exchanges; the fruits of the work being (nominally at least) not for the benefit of outsiders. More lately, interests which, while not allied, were at least non-competitive, have found it to their advantage to confer with one another—principally, perhaps, with regard to the purchase of machinery—so that at present it is quite common for a firm to answer dozens of letters weekly from parties who have been referred to them regarding their experience.

Still more recent is the development of a practice of exchange of information between strictly competitive enterprises. A striking example of this is in the well-known American railway associations, in which the motive-power men meet yearly with the full sanction and approval of their respective roads, and confer freely with their business rivals regarding economical methods of railroading. In other fields, too, the same practice is being followed with success. Even two adjoining manufacturers—keen competitors for certain lines of trade—will confer, with no intention or desire to agree upon prices, but simply to compare notes regarding troublesome details of the business. There is safety in this, as no man can have an absolutely certain knowledge of his own costs, nor proof positive that his customer may not be deceiving him. An opportunity for competitors to compare may be of mutual benefit in giving to the one information that will prevent him from making an unprofitable quotation, and for the other obviating the necessity of meeting an unprofitable quotation in order to retain the business.

In the development of a spirit of co-operation such as has thus become prevalent, the examples of the engineers' societies and of the personality of their membership have played no small part. In the ultimate fruits of this development it is probable that the engineer will be a leading figure.

PROSPECTING IN WESTERN MEXICO.

By Theodore S. DeLay.

Mr. De Lay, in an introductory note transmitting the following article, explains that it is dedicated "to any man who contemplates a prospecting expedition in Mexico. The aim has been to point out and explain such of the conditions of the business as are peculiar to Mexico. If anyone, after having perused the pages, should find himself thereby better able to cope with the difficulties of such an expedition, a rather unprofitable experience of the writer will not have been wholly fruitless." Mr. De Lay has the happy faculty of investing his article with the breadth of interest which makes it unusually pleasant to read, and profitable beyond the strict limits which he proposes for it.—The Editors.

ANTICIPATING a probability that some one will find the opinions of conditions and people, which I may set forth in this article, different from those which he has formed from his own experience, I have to say that there are various conditions and people in the universe, and it is only reasonable to suppose that Mexico may contain several different kinds. I shall attempt to give an idea of such conditions only as I have found, and such people as I have happened to meet, in a limited experience in prospecting on the Gulf of California coast.

I could not advise any one to start to Mexico seeking a high-grade proposition which may be worked with small capital. My opinion in this is based on the following facts:—

A more or less scientific system of mining and metallurgy was practised in many localities in Mexico long before the California discoveries gave American mining its great impetus. These operations were carried on under the supervision of the priesthood, and for the benefit of the church. At that time the population of Mexico was fanatically religious; therefore, anything pertaining to the interest of the church would attract the interest of the public at large. These ecclesiastical mining plants did not require a special and exclusive class of operatives, but employed any and all of the communicants who were not otherwise occupied. It follows that nearly all the laborers of the country would, at some time or other in their lives, be employed in mining operations.

In later years the American and German miners have made Mexico a field of operations, and have installed comparatively recent methods. Some of the first successful plants for the Russel hyposulphite process were located in Western Mexico, such as the San Marcial and La Brancha plants, while at La Dura there is (or was, in '97) the best concentration plant I have ever seen. These foreign enterprises have been no respecters of persons, as regards their native laborers, employing the first person who appeared to fill a vacancy; and since a few dollars in hand makes the average Mexican laborer too rich to work, vacancies were not infrequent. From all of which it follows that the conditions have been favorable for a general dissemination of practical mining knowledge in Mexico.

Now, the Mexican, while not of strong mentality, has the faculty of observation strongly developed by close contact with nature, and has the capacity for accurate imitation characteristic of all semi-civilized peoples. Hence, we may expect to find him a good off-hand judge of ore, quite skilful in tests with the "batea" and horn spoon, and even able to supplement these with rough roasting and amalgamating operations. In nearly every Mexican home, however lowly, one will find specimens of ore, with which the children play while they listen to the talk of their elders about the fortunes which have been gained by the turning of a stone. The Mexican is as patient as his burro—content with little to eat, and less to wear. Hope springs ever immortal in his breast, and he is possessed of a distaste for continued labor with sure results, and a fondness for trying his chance with the fickle dame, Fortune. These two latter characteristics are a basis for the gambling temperament, which is a prime requisite of the adventurer. Lacking the qualities of courage, energy, and industry, our "Greaser" has nevertheless some very good points for a prospector and miner on a small scale.

In a country over every foot of which men of the above character have been roaming for generations, either directly in search of mineral or as herders, yet ever with an eye open for "*piedras ricas*," there is small chance of there remaining anything which can be seen at surface and worked without capital. One is continually surprised at the thoroughness with which Mexico has been prospected by these "*gambozineros*." I have many times found myself in a country so wild and desolate that one would be justified in supposing that it had never been trodden by the foot of man, yet a search over a few acres would generally reveal a prospect hole. But the *gambozinero* is not tenacious of purpose, and rarely follows a vein far after he has lost the pay, so that there is opportunity for someone with capital to take up and develop an old mine which has once paid, and may again pay with depth. The Creston, Colorado, and Pietras mines are all of this class. The Mexican is not posted on the most economical metallurgical processes, nor is he careful to get the best results from the processes which he knows. So long as his operations pay well, he gives himself little trouble if his tailings do run high. There is, therefore, a chance of finding some old bed of arrastra tailings, or the slag dump from some ancient smelter, which will pay well for reworking by modern metallurgical methods. The Mexican Metallic Extraction Co. (branch of the McArthur-Forrest Syndicate) has several plants in western Mexico, where large returns are realized by cyaniding old arrastra tailings.

The Mexican is unable to treat low-grade ore, and he is neither able nor inclined to dig very deep on a low-grade vein in the hope of its becoming rich with depth. So there is always an opening to work low-grade veins and to block out sufficient ore to make it sell to a syndicate; but that takes money. Another line in which there is, or was some three years since, an opening for a mining man of some means, is ore and metal buying. The ore buyers rob the native miner, and one could over-bid them and still make large profits.

There are the above chances for success on the part of a prospector. There are probably others which I have not observed, but I can safely advise any one not to go to Mexico expecting to find the wealth of the Montezumas kicking around under-foot. Don't follow the stories of "veins of rich ore, basking in the light of the tropical sun, and waiting for Anglo-Saxon knowledge and energy to develop them." There is probably no known ore of gold or silver, carrying over twenty dollars per ton, the approximate value of which the Mexican prospector would fail to find if he should try; and if it were exposed, the chances are that he would find and try it.

In outfitting to go to Mexico, one should know some time beforehand so that he may buy and use the articles a little while at home, for it is much less difficult to pass the Mexican custom officers with a set of things which are somewhat worn than with a new outfit. Shoes and clothing are especially high in Mexico, and in selecting these one must have not only an outfit for rough work in the hills, but also for town and social wear, as in learning the language the social side of life in Mexico is not to be despised by the prospective prospector.

For working clothes, I have found brown cotton-duck of close texture and light weight the most serviceable. For town use, one-half dozen or more suits of white linen or crash will be found serviceable for summer, while for winter wear, ordinary woolen clothes are good. In providing foot-wear, one should remember that Mexico is a stony country, and about twice the ordinary amount will be required. If one has any knack for tinkering, a small shoe-repair outfit will be found very useful, as the Mexican cobbler is a brigand in disguise. One should take a riding outfit—saddle, bridle, spurs, and saddlebags. Not that any money will be saved in this way, for it is nearly impossible to get these things through the custom house without paying an exorbitant duty; but all leather manufactured in Mexico is villainous, and the satisfaction of a good outfit when you are nearly living in the saddle will more than compensate for any added cost. Blankets, and all kinds of bedding, are scarce, poor, and dear. One should take at least two pairs of ten-pound California blankets, or other bedding of equal warmth, and an 8 by 10 A tent of 8 or 10 ounce duck, made with a flap at both ends so it will open out flat.

A rifle and shotgun will be found useful, as there is large and small game throughout Mexico. Take plenty of ammunition for each, as that comes high, and there is not a good assortment for sale. A small medicine case will be of value. It should be stocked as much as possible with drugs in dry state and a few simple surgical appliances. Tobacco for smoking is very cheap in Mexico, but American chewing tobacco is very dear. Whether one is a chewer or not, it is advisable to take all that can probably be taken through the custom-house (five or six pounds) as a speculation, if not for personal use. Cooking utensils are to be had at a price that makes it not worth while carrying them along. But if I were going again, I should take along a small, but durable, camp-stove with an oven. Bread is not to be had outside of the larger villages, and one gets exceedingly tired of the "*tortilla*" and camp-fire "flap-jack." If he who is going is a technical graduate, he should take along a very small blow-pipe outfit. More than this it is not worth while to carry, as there are assay offices in many of the small native mining camps, and the proprietors of these are always exceedingly courteous in extending the customary privileges to fellows of the craft.

In completing that portion of your outfit which you take from home, remember that the many little incidentals to which we are accustomed are used in Mexico by foreigners only, and are accordingly high, as Mexican political economy accomplishes in a measure what is unsuccessfully attempted by American protectionists, i. e., to make the foreigner pay. It is not feasible for a private individual to have anything sent by mail or express into Mexico. The charges for red tape are ruinous if the article ever reaches its destination, and it is not likely to do so if it happens to excite the cupidity of any of the inspectors through whose hands it passes.

The first *thing* one meets on crossing the border into Mexico is a customs officer. In dealing with these, one should not pretend to be at all "fly." Be modest, quiet, and perfectly frank; open your packages without any hesitation, and do not molest nor bother the officer in his inspection. If you do this, he will probably be very superficial in his search. But he is naturally suspicious, and any subtilty, hesitation, or fussiness on your part will lead him to a very thorough inspection. Above all, be pleasant and courteous, for these qualities count for much in dealing with the Mexican. With whatever success one passes the border, he may be glad when he has passed, as he will there have come in contact with the most villainous class of Mexicans. The Mexican, like all other races, develops an additional rascality on contact with the Anglo-Saxon. But let the traveler not congratulate himself that he is clear of the customs when he is safely across the border. Mexico has not only national and State customs, but district and village customs, so that at every turn one meets with the ubiquitous customs officer. They even board the trains at way stations, and attempt to extort from such passengers as look "green" and "easy."

The first thing to be done on arriving at the locality wherein you wish to prospect is to learn a little of the language. It is well to secure work in some mine or metallurgical plant while doing this. But if you cannot get work, try to find a village where there are none of your countrymen, and secure board there. When you have acquired sufficient of the language to make yourself understood, and to understand short sentences, you will be able to make your way in a prospecting expedition. The best time to start out is in the early autumn, as the season of extreme heat, rains, and floods is then past, and you have three months of good grass and water ahead before the height of the dry season.

The points of the most vital importance in the outfitting are good pack and saddle animals. It is much better policy to buy animals than to attempt to rent them. The rates of rental are high, and the animals are invariably bad. Around the villages is a poor place to secure animals. The better way is to go to a horse ranch owned by some responsible Mexican, and there select and buy your animals. In doing this, there are many things to be taken into consideration, some of which I will try to outline. It is best to get animals which have been born and raised in the mountains, as those raised in the river valleys are not sure-footed, nor sufficiently tough in the legs and hoofs. In addition to the ordinary "points" too numerous to consider here, there is one thing for which a particular look-out should be kept. This is known as "stickfast" in English, and *"matado"* in Spanish. A saddle-gall is, in warm climates, very likely to work down and injure the periosteum of the vertebra; an indurated growth is then induced; the sore may almost, or quite, heal, when the animal is turned out to rest, but on starting him under the saddle again it immediately breaks out. It is surprising how many of the animals offered for sale are thus afflicted. Every animal should be subjected to a very strict digital examination along the vertebra, and if he shows the least sign of tenderness at any point, he should be rejected.

In selecting a burro, I prefer a "chunky" gelding from three to seven years of age. I would particularly avoid an animal with a large rough head,—a *"cabezon"* as the Mexicans call him; he is likely to be foolish, slow, awkward, and weak. In horses, I prefer the "rangy" ones, as a chunky horse seems to become lazy and spiritless in hot climates. Two burros will probably be needed, and they should not cost more than $12 each. A good saddle horse should not cost more than $45. (In this article I shall speak of Mexican money.)

In Mexico unbranded mature animals, and animals which have been "vented" by a second application of the original brand, are considered "mavericks," and become the property of whoever can get possession of and put his brand on them. It is customary in the transfer of animals for the vendor to vent the animal, and the purchaser to apply his own brand; but, as branding disables the animal for several days, and as a prospector is not likely to have a brand of his own, the best plan is to take a bill of sale when you buy an animal, *with a drawing of the brand.* Then the brand holds the animal the property of the owner of the iron by common law, and your bill of sale shows for your title.

As equipment, you will need bells, bell collars, hobbles, ropes, and packing apparatus. After you have secured your animals and arranged their equipment, supposing that you have brought your riding outfit, the next thing is to secure tools, camp utensils, and food. For mining tools there will be needed a poll pick, a short shovel, a gold pan, a couple of steel gads, and a mortar. An axe for wood-cutting is needed, and a hatchet to use in hacking around camp and sharpening pick and gads, while a machete or brush knife to carry on your saddle is worth its weight in—well, at least in silver, when traveling in a cactus country. A belt punch, some copper rivets, a small pair of pliers, and plenty of buckskin or lace leather will come handy in repairing harness. It is not worth while to carry powder and drills, as they make great additional weight, and you will be doing more tramping than digging for the first two or three weeks. They can be had at any supply point, when you do find a place where you want to dig.

In selecting camp utensils, one must select as for any other camp-life, where transportation is by pack animal. One line that should not be neglected is canteens, as one frequently has to carry drinking water. In making up a grub outfit, individual taste must govern to a large extent; but I would suggest, do not hold the Mexican foods in too much aversion. Imported goods come high, and are not as good for that climate as the native product. One can sometimes get eggs, milk, cheese, and fresh vegetables at the ranches on the way, but it is not to be depended on. The money you expect to spend on the trip should all be carried in Mexican silver and copper. It is practically impossible to change American money in Mexican rural districts, and many of the natives will not receive Mexican national bank bills; a good supply of small change should be carried as the Mexican is prone to price things at three, six, and thirteen-cent rates.

Having now prepared your traveling outfit, the next question is, where are you going? You will probably, long ere you feel yourself prepared to start, have been accosted by numerous individuals who have mines more or less distant. The first proposition of one of these Mexican prospectors is, usually, that you grub-stake him; failing that that you go with him and look at the mine; failing that, that you loan him two dollars. Never grub-stake a Mexican. If you give it to him in cash, he will spend it on a glorious drunk before he leaves town; if you give him provisions, he will take them out to the mine—if there is one; if not, to any suitable point, and assemble his friends and relatives and proceed to a protracted picnic. If there be any of the assembly who do not feel themselves up to the mark as vocalists or dancers, they may go out and dig for an hour or so, occasionally; but on the whole there will be very little work done for the amount of grub eaten. Never let one of these *"coyote"* miners undertake to pilot you to his mine, or anywhere else. He will have a number of ranchers of his own feather along the route of travel, with whom he has a definite understanding. He will pilot you to them for entertainment, and they will charge you outrageous prices for most villainous accommodations. In return for this favor, the rancher keeps the *coyote* whenever his wanderings bring him that way. Never loan money to one of these *coyotes;* it will not even have the effect of getting you rid of him—he will come back to borrow more as long as he thinks there is a chance of getting it.

Do not be excited about any of the stories they tell you; the lower-class Mexican is a cheerful liar, preferring prevarication when truth would better serve his purpose, and the mining business is his particular field of mendacity; listen courteously to his yarns, if you have time to spare; then tell him that you expect soon to be traveling in the vicinity of his property and will take great pleasure in inspecting it. In the meantime, inquire among your Mexican friends as regards his character, and how big a liar he is.

A very profitable side-occupation, while learning Spanish, will be the drawing of a map of the district through which you expect to travel. Aggregate information from such maps as you can get, and from the conversation of such people as you may consider reliable. Pay considerable attention to trails, natural obstacles, distances, and watering places. Now mark the location of such of these *coyote* mines as you think worth visiting, on your map. When you start out in the hills, you will do well to spend a few weeks looking at these prospects. It is altogether possible that you will find some of them making such a showing that you will see fit to stop and put in some work on it. In case you do, do not go into any sort of partnership with the Mexican owner. Make your deal to buy out all his right and title. If nothing is shown to you that attracts you, you have at least the benefit of observing the formation of the country at some other person's expense of digging.

In traveling it is a good plan to go early and late, and rest in the middle of the day; arrange to pass watering places about two hours before time to camp. Stop only to water your stock and fill your canteens, then go on and make your camp where there is pasture for your stock, which will not be the case anywhere within six or seven miles of a watering place. On the first night out, and whenever camping within thirty miles of where your stock was raised, all stock should be picketed; at other times the burros may be turned loose with hobbles and bells; your saddle animal should always be picketed, as a horse or mule never gets the knack of shortstepping and traveling easily with the hobbles on as does a burro, but goes jumping and stumbling, thus spraining and bruising himself so that he shortly loses his sureness of foot when under saddle.

In making camp, it is necessary to place your meat where the coyotes cannot get it—either under the head of your bed, or better, hung up in a bush. A coyote once stole a sack of dried meat from under my head when I was asleep, and I had not been looking on the wine cup either. One has need of a watch-dog. For this reason, and to assist in driving the burros, I think a shepherd dog would be found well worth his keep to a prospector. If you have a Mexican boy, you must nevertheless see that everything is properly attended to; the Mexican is not to be trusted with any responsibility.

In traveling through the country, you will at first have considerable difficulty in finding the way; the roads are mere trails, and are likely to be joined and crossed by numerous stock paths, which are better beaten than the road itself. The ignorant Mexican is very poor at directing one; he has only the most rudimentary ideas of distance. A place to which he is accustomed to make frequent trips, stands in his mind as *"cerquita"* (near), while an unknown locality is *"lejos"* (distant), though the actual distance may be less in the latter case. Another thing that will complicate your difficulties is the fact that the accent and dialect will change with every fifty or sixty miles you travel. Above everything, do not attempt to use any word of English in conversing with one of these ignorant natives; if you are unable to call up a word you wish to use, you may make signs, or leave it out, and he may infer your meaning, but the substitution of a single English word in a sentence will put him in a state of mental stampede.

When traveling with pack animals, it is very necessary to arrange your camping places so that you will not have to make an extra long day's march. About ten leagues (thirty miles) is proper for a loaded burro. You may divide this up as you like, either early and late, or a regular work day, or, as is frequently done in the hot season, make the whole march after night. If your burros are good ones, they will make the ten leagues, with a short rest in the middle, and act in a very decent manner; but after that distance they develop an ingenuity for "cussedness" that is remarkable. They will run off the trail, catch their packs under every low limb, get packs and saddles disarranged, and be altogether incorrigible. As the driver under these conditions will be tired and angry, he is likely to fail to give proper attention to the saddle padding, with the result that the animal will acquire a sore back, thus making trouble for months to come. In case an open abrasion does appear on the animal it should be protected by a coat of tar when not covered, as it is liable, especially in hot weather, to become infested with maggots, thus necessitating an application of quick lime and insuring a bad scar, if not formation of fistula. Yellow gnats will prove a continual pest to the eyes of the animals, particularly the horse; they cause a mucous discharge from the eye and keep up such an irritation that the horse will keep his eyelids and cheeks raw by scratching. The best alleviation is a brow band, with pendants of cotton cord extending down over and below the eyes.

When you camp near a ranch house, you are likely to be visited by vaqueros wishing to show you mineral indications of which they know in the vicinity. These fellows are in the main honest, and do not expect any immediate reward except an occasional meal at your camp. If you have time—which should always be the case in Mexico—it will do no harm to go with them and look at their prospects; they are likely to over-estimate what they have, but you may depend on it that they have seen everything in the mineral line that is at surface in their locality. It will be well to question them as regards any ancient metallurgical ruins that may be in the locality, for the old native slag dumps and beds of arrastra tailings are some of the best things to be found in Mexico. Right here it will be well to mention an error into which many prospectors fall. On finding one of these ancient metallurgical plants, they argue that there must necessarily have been a rich mine in the immediate vicinity to furnish ore for such extensive operations. This theory looks plausible, and is supported by the numerous vague stories of the natives about rich mines that were buried up and concealed by the missionary "*padres*" at the time they were divested by the Government of their absolute authority in that region. Much time and money is thus spent in looking for the mine, when, as a matter of fact, the metallurgical plant had its location by reason of proximity to water, fuel, or the mission, the ore having been brought from dozens of little mines at various localities many leagues apart.

If, after visiting numerous *coyote* mines, you decide that none of them is worth your attention, it will be in order for you to find a region wherein to prospect yourself. In doing this, it is not well to put too much credence in native rumors. The Mexican has the faculty of investing every inaccessible locality with great mineral possibilities—as, for instance, the case of the Bacatete mountains in the Yaqui Indian reservation in southwestern Sonora. This range has been closed to exploration for many years on account of Indian hostilities. The result is that the most fabulous stories are current in Sonora of the mineral wealth of the Bacatete range. On the strength of these stories I once seized upon the opportunity, when the Indians were in a comparatively peaceful state, to spend a month prospecting in this range. I traveled from one end to the other of it, finding the country composed of the volcanic rock known locally as *malpais*, and utterly without visible mineral indications.

When, after giving these matters due consideration, you have selected a locality in which you desire to prospect, it is well to find a point as near to water as it is possible to find pasture for your stock, and there establish a camp. From this you can radiate until you have prospected a territory three or four miles in radius. If it comes convenient, it is well to ask permission of the rancher on whose land you are prospecting; he will rarely, if ever, fail to give it, and the courtesy serves to establish the *entente cordial* for further relations. He will also inform you if any one has a "*zona*" (a sort of mineral option to be later explained) on the land where you are working, in which case you will wish to leave it.

Many writers of more or less practical knowledge have attempted to give directions for prospecting. They have probably done it as well as possible, and as their works are available to every one I shall not make much attempt to enlarge on this subject. Successful prospecting seems to be more a matter of chance and the semi-instinctive knowledge acquired by experience than of science. Scientific knowedge has its legitimate place in the business, and should not be by any means underrated. I should place a natural tendency for close observations and logical deductions therefrom as of equal value, while a combination of the two is a qualification unexcelled for the man starting into this line.

The conditions of "rock hunting" are not very different in Mexico from those in any locality, except that in the mountainous districts the soil is thin or absent and the vegetation sparse and scattered. This, of course, greatly facilitates the work. My favorite method is to work up the beds of the water-courses looking for mineralized float. Failing to find it there, I go along the hillside about half-way up, turning over and breaking any promising bit of rock; failing there, I work along the crest where the rock is in place; if none of these localities show any mineral indication, I pass on. If a piece of mineralized float is found, the amount and character of the attrition considered in connection with the lie of the country will give evidence of how far it has traveled, and whether by water or by gravity. The comparative amount of oxidation on the surface and interior of the fragment will give indication of the time since it was fractured from the ledge. In reaching conclusions, one should ever bear in mind the possibility of ungeological causes, as the dropping of ore from a pack train.

If you find anything, it is advisable to keep silence about it, and even cover up your work until you have taken the first of the legal steps to be hereinafter described. There is not the same sense of honor about "jumping" in Mexico as in the United States. The first legal step, the *zona,* is in effect an exclusive option to locate mineral within a certain area, usually about 1,000 metres radius within a given length of time (90 days); it is renewable once. The expense of securing it is about $15. No survey is needed, but you must have a care that the description of it is reasonably definite, and that you apply for it at the capital of the district where it is located. The word of the officers in the office of record is not to be relied on for this, as they are likely to record and give a *zona* anywhere, if there is a fee in sight. The ranch people around where you are prospecting can tell you in what district you are working. Having taken out your *zona,* you may now go ahead and work openly on your prospect, without fear of jumpers. It will be well to follow your vein to at least thirty feet of depth before going to any additional expense. There are a surprisingly large number of veins in Sonora, particularly those carrying copper, which appear to be just the bottom of an ancient fissure vein, the upper part having been eroded. On following them to a slight depth, they utterly pinch out, leaving not the slightest leader to follow.

I once found a vein of this kind which consisted of about an inch of nearly pure chalcocite, carrying 62 per cent. copper and nearly 100 ounces of silver. This was flanked on either side by about six inches of oxidized material carrying about 20 per cent. copper and 10 ounces of silver. The ground was covered by a *zona,* held by some parties who were prospecting an adjacent vein. I covered my work, and waited for the expiration of the *zona,* when I started back, considering my fortune made. I found that my predecessors had discovered my prospect and had dug down about sixteen inches, with the result of digging out every trace of a vein. I afterwards learned that they had found outcroppings of the same vein at different places along a distance of about two thousand feet, and had sunk several times with the same result. I have seen practically the same thing occur a number of times on work done by my friends in Mexico. Hence, I advise a considerable development of the vein before any great expense is incurred.

In carrying on your work, it may be necessary to hire Mexicans, and you will find them fairly worth their wages as miners, so long as you stay right with them and set them a good example. It will be advisable to get a supply of "grub," cigarettes, and other Mexican necessities, and sell to them as they earn wages. You can charge a good big profit, and can practically pay in supplies. But never let them draw much in advance; better not at all.

If, at the expiration of your *zona* you conclude that you want the ground, you must then "denounce"; this consists of a formal declaration that you have found metalliferous mineral in paying quantities at a certain place. This must be filed at the mineral capital of the district. The cost of this is $25, and in making it, you may ask for and receive as many "*pertinencias*" as you like. A *pertinencia* is the mineral right to 100 metres square of land without extralateral rights. It carries with it surface rights to sufficient land for the erection of the necessary machinery. Any further surface rights must be bought from the owner of the ranch. If he is obstinate, you may have the land condemned and appraised by law. The "*denunciamento*" must be followed within sixty days by a survey made by the mineral surveyor of the district. There is no regular fee for this; it is to be settled by a bargain between the surveyor and yourself. After the survey is made, the papers are sent to the City of Mexico, and in due time the title will return without further cost except the revenue stamps. After this, you must pay an annual tax of $10 per *pertinencia* for gold and silver claims, and $2.50 for copper. A failure to pay this forfeits all rights. No assessment work is required. This is the process of obtaining title to metalliferous mineral veins.

As regards placers, I am not posted. Old beds of arrastra tailings, old slag dumps, and coal, belong to the man holding the surface right, and must be bought of him. On all gold and silver mined in Mexico, a mintage charge of 10 per cent. is made, whether it is minted there or exported in the ore.

Finally, in carrying on any kind of mining or metallurgical operation in Mexico, it is necessary to exercise great caution against theft of rich ore or mill products by the employees. Popular opinion holds that the mineral riches of the earth are for whoever can lay hands on them. I am sorry to say that this theory permeates the Anglo-Saxon mind on long residence in the country. The greater intelligence and daring of the Anglo-Saxon has given him a reputation in villainy, embodied in the Mexican proverb: *"No hay otro coyote como un gringo sin vergüenza"*—"There is no rascal like a shameless Yankee."

EDITORIAL COMMENT

THE condition of the suspension bridge between New York and Brooklyn is a matter of most material importance to those cities—indeed, of very vital importance to many of the inhabitants ; but beyond all that it has a strong popular interest reflecting the feeling displayed by every writer who has ever discussed great bridges and bridge building in THE ENGINEERING MAGAZINE. The late Mr. T. C. Clarke, Mr. Gustav Lindenthal, Mr. Albert W. Buel, Mr. E. C. Gardner—each primarily concerned with a very different aspect of bridge construction—all find themselves to some degree inspired by the picturesque, it might almost be said the romantic, atmosphere surrounding a great structure of this sort. This appeal to the imagination heightens the interest which would in any case attach to the report of the experts appointed to examine the Brooklyn Bridge.

It is unfortunate that this report should be made public at a time when it will inevitably be regarded by many as a political weapon aimed at the local administration. No one will for a moment suspect the engineers who framed it of any political bias, even the slightest, but the fact that the officials to whom the report was presented have selected the height of an active and heated campaign as the moment for its broadcast publication will almost inevitably detract from its effectiveness as a painstaking, serious, and very important professional opinion.

The most immediately striking elements of the report are the statements of overload which are made without qualification. Working stresses of 71,000 pounds per square inch in the main cables, exclusive of any additions arising from wind pressure, are extremely high. At least as much must be said of the calculated pressures in the tower masonry—39.6 tons per square foot. And the stresses in the floor members are correspondingly higher than safe practice would contemplate—27,000 pounds per square inch in intermediate floor beams of railway tracks, 25,000 pounds per square inch in intermediate floor beams of roadway, 34,000 pounds per square inch in some of the channels, 17,000 pounds per square inch in others—all against a permissible working stress of 14,000 pounds per square inch. Many of these conditions could be referred only to defects of design. Throughout, the engineers have confined themselves to stresses of considerable size, which can be calculated with substantial accuracy from the data available, but there is a certain element of ambiguity arising from the impossibility of securing all the needful data.

Herein lies the second most startling development of the investigation. Of a great and important bridge, carrying probably the greatest daily traffic of any similar structure in the world, which has repeatedly been the subject of expert examinations, which has for years been under the charge of highly salaried and supposedly competent officials, the committee of inspection is forced to say: "The lack of adequate plans of the bridge is such that a complete survey of the structure would be necessary in order to obtain a full and reliable knowledge of its members."

The remaining development of importance is almost matter-of-course to anyone familiar with existing methods in New York City political departments. It is merely the exposure of gross negligence and indifference in the inspection and care of the structure. It is recommended to those who are ardent for municipal ownership and operation of public utilities.

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THE result of the Cup races evidenced in the most conclusive manner possible the almost marvellous *rapprochement* of naval architecture and what might be called "sailing-machine design," at least as between England and the United States. Considering sailing time as the measure of efficiency, the difference between two structures, built three thousand miles apart, was hardly ever as high as one per cent, and in the last race was scarcely more than four-tenths of one per cent., reckoning in the time allowance, and almost too small for expression by figures, reckoning boat for boat. When the comparison comes as close as that the most minute conditions may determine failure or success. And, in the view of wholly disinterested authorities well qualified to judge, the structural and tactical handicap imposed by the condition that the challenger must cross the ocean under her own sail, while the defender need not, is much more than a trifle. It was prescribed when the contesting yachts were merely very finely modelled examples of the yacht building of their time—cruising boats, like others of their class except for superior excellence of design and finish. Now that the contestants have become a class by themselves, practically serviceable for no other function, it would be a matter of great satisfaction to many sportsmen and students of marine construction everywhere if every possible artificial handicap or advantage could be removed and the absolutely equal test of boat building and boat sailing be divested of every other disturbing condition.

HERR LÜDERS, in the conclusion of his most instructive review of Machine-Shop Practice from a German View-Point, which appears elsewhere in this number, speaks of the accounting and cost-keeping system as the "real soul of every works." It is perhaps not easy to find a physical or a psychical analogue for the cost-keeping department, but it is certain that many and many an undertaking goes to destruction for lack of it, or for lack of intelligent reliance upon it. It is the steady monitor of business conditions, the unfailing adviser and guide in commercial transactions, the unerring balance by which to weigh the profit of routine or extraordinary ventures, the check and corrective of over-confident enthusiasm.

And it is remarkable to see how widespread is the recognition of the essentiality of a sufficient cost-keeping system in the works, and how close is the study managers everywhere are putting upon the problem of cost-keeping principles and their application.

An interesting and important department of our editorial mail is forming from the many inquiries touching adaptation of methods described in the Magazine to conditions arising in particular lines of business, or suggestions carrying to further extension the basal principles laid down by such authorities as Mr. A. Hamilton Church, whose comprehensive discussion will close in our next issue. And in such inquiries and comments often lies the suggestion of important new ideas awaiting development by the new applied science of cost-keeping—a science whose literature is now in process of making.

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WITHIN certain limits the "official" fetish has been regarded with less awe in the United States than in almost any other country, while at the same time there is hardly any country in which official utterances and publications have been more generally received as authoritative and employed by civilians with confidence. Especially has this been true of the publications of the War and Navy Departments. In England especially has favourable comment been made on the freedom with which important Government bureaus in America have published information which would have been most carefully secreted from the profanation of public gaze at Whitehall, and the reports of the Bureau of Steam Engineering, of the Ordnance Bureau, and the Bureau of Construction and Repair, for example, have been accorded even more consideration as scientific professional papers than the transactions of the great national societies.

We are now, however, beginning to feel that some of this confidence may have been misplaced, for when, as in a notable, or perhaps notorious, naval inquiry recently at Washington, we find that official maps, endorsed as correct by high officials, and given to the public with the authority of the Navy Department, are thrown out of court as confessedly worthless on the testimony of those who assisted in making them, we wonder how much more of this sort of thing has been going on.

Not only maps, but official logs of battleships and cruisers have been admitted to be garbled and incomplete by those whose duty it was to see that they were kept scrupulously correct, entries of vital importance having been omitted at the will or whim of responsible officers.

The most discouraging thing about all these revelations lies in the apparent indifference with which they have been regarded by officialdom in general. No attempt has yet been made to explain that these glaring examples of misinformation are exceptions or accidents. On the contrary there has been a disposition to pass them over as immaterial or unimportant. They cannot be so regarded by the engineering profession at large, and unless something is done to restore the confidence which has been disturbed by these revelations the official records of the Navy Department of the United States may soon be ranked with the bordereau of Esterhazy, and banished from the shelves of civilian engineers as no longer worthy of confidence or respect.

Another noteworthy circumstance is the official confirmation of the startling disclosures made by Mr. Arthur Warren in THE ENGINEERING MAGAZINE for January, 1899, of the unreadiness of some of the ships, under the command of deck officers. An instance is the proof from the steam log of the Brooklyn that she had her forward engines uncoupled, banked fires under three boilers, and others filled with cold water or empty and fires not even laid. Thus what the line officers heatedly characterised as the charges of a civilian prove to be officially recorded facts.

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THROUGH an inadvertence of statement in the article on "Mechanical and Electrical Features of the Buffalo Exposition," which appeared in our September issue, the multi-voltage system of power distribution was made to appear as an exclusive or peculiar feature of the practice of the Bullock Electric Manufacturing Company. The phrasing was changed in the last proof submitted to the editorial office, but the correction was overlooked by the printers, and so the printed page contained the paragraph with the faulty reading attributing the system to the Bullock Company as originators, instead of the intended one stating that the system was exhibited by them at Buffalo. As a matter of fact, this system has received special attention from the Crocker-Wheeler Company, and one of the first establishments to be successfully equipped with the system was that of Sir Joseph Causton and Sons, at Leeds, where the Crocker-Wheeler Company put in some seventy odd motors on multiple-voltage system some three years ago.

REVIEW OF THE BRITISH PRESS

Improved Workshop Methods.

The subject of works management is one to which this magazine has given much attention, and hence we are gratified to observe the extent to which its lead has been taken in papers and discussions elsewhere. Three papers at the Glasgow meeting of the Institution of Mechanical Engineers treated of various phases of the subject, including the remuneration of labour, the economical manufacture of marine engines, and general workshop methods. The paper upon the last subject, contributed by Messrs. William Weir and J. R. Richmond, contains some especially interesting features, giving details of the working and general results of the premium system, a foreman's club, a suggestion scheme for improvements, a technical committee for dealing with new designs, and an intelligence department, for the collection of data on various subjects relating to the work of the establishment.

The premium system has been fully discussed in the pages of this magazine, and the suggestion scheme is practically in line with what has already been so admirably carried out at the works of the National Cash Register Co., at Dayton, Ohio, and elsewhere, but some of the other features are most interesting.

"To secure a proper discussion on shop problems, and to provide machinery for the systematic carrying out of suggestions and reporting of results, it was decided to inaugurate a club composed not only of foremen, but of all the administrative heads of departments, drawing-office, costing department, correspondence department, &c.

"When the club was first proposed, its reception was not at all favorable; it was considered by the foremen that the discussions would breed dissension, that reflections would be made by one foreman on the work of another, and that generally it would give rise to internal friction. It was accordingly named the "Friction Club," on the principle that its mission was to be the elimination of friction. Its business was to discuss shop problems and decide on solutions, to institute improvements and provide the means of carrying them out to finality; to receive and adjudicate on complaints and suggestions. Its rules were made as elastic as possible. Its office-bearers consist of an executive committee of five, three chairmen, who preside in succession, and two joint secretaries. Meetings are held once a month, in the evening; the proceedings are reported and copies are neostyled and given to each member, for insertion in a spring binder with which he is provided. The business of each meeting is arranged by the executive, and deals with whatever shop questions are most pressing.

"A club letter-box is provided in the shop, into which members are requested to send notes on suggestions or subjects for discussion. This box is opened by the executive committee prior to the issue of the notice for the following meeting, and if any matter requiring discussion is received in the box, it is incorporated in the business for that meeting.

The club was started at first with some misgivings, but it has steadily improved, and has taken its place as a most helpful factor in the establishment.

Among the matters dealt with by the club have been the following:

1. The establishment of a works library, containing books and current technical papers and magazines. The weekly technical papers are available for members of the club one week after publication, the monthly magazines one fortnight. Books can be borrowed at certain hours from the library, and the private technical libraries of members of the firm are made available to members on application. (2) The workmen's suggestion scheme, as described later in the present paper; (3) the admittance and course of apprentices in the works; (4) the

lighting of the shops; (5) the arrangement of the firm's exhibit at the Glasgow International Exhibition; (6) the distribution of shop labourers; (7) shop hindrances—a report by each foreman on his department, indicating the hindrances interfering with the execution or output of the work of his department; (8) grindstones *versus* emery wheels; (9) wearing of overalls, etc.

The decisions of the club are, where necessary, submitted to the directors, and receive their sanction before being put in operation; but as each of the three chairmen of the club is a director, this is usually a matter of form.

The other feature in the paper to which especial attention is directed is the "intelligence department." This department deals with the collection of information and data required by the various departments and members of the firm; the indexing, cataloguing, and filing of technical literature, catalogues, cuttings, &c. It secures a systematic perusal of contract advertisements in the technical papers, marks and records openings for the firm's products, and keeps a card index of parties interested or likely to be interested in them. The principals or heads of departments furnish notes of special subjects on which they desire information, and articles in current magazines or papers are marked for their. perusal. When the subject is a general or voluminous one, such as water-tube boilers, Romeike and Curtis can be requisitioned. The technical index of the "Engineering Magazine" is also utilised, and special articles are obtained by coupon when required. These cuttings are filed under department or subject heads in cardboard cases for reference.

Suppose the firm is considering any problem, say foundry equipment, the intelligence department is requested to collect the articles dealing with the subject; the various yearly indexes of technical papers are gone over; and, if need be, a summary is prepared for the technical committee, or the individual member to whom the question has been remitted. This method saves the time of the more expensive staff, and is a means of readily obtaining concentrated information with a minimum expenditure of high-paid labour.

If competitive business is considered as commercial warfare, such an intelligence bureau may be compared with the departments of official information by nearly all governments in order to enable them to be kept abreast with possible rivals. Such an office, properly maintained and actively used should conduce to great economy by avoiding duplication of effort, saving the results of costly experiments already undertaken by others, and the maintenance of a general state of readiness to receive whatever is new and valuable, or to reject whatever may be old or worthless.

That such organised measures should not only be advocated, but already adopted, is welcome evidence of the progress which is being made in workshop administration, progress which cannot but work to the benefit of employers, employed, and customers.

Recent Developments in Locomotion.

The Presidential Address of Col. R. E. Crompton, before the Mechanical Science Section of the British Association contains an interesting discussion of some of the recent developments of locomotion on land which, as he well says, demand the best thoughts, not only of engineers, but or every one interested in means of travelling and in the more rapid transit of goods.

Reviewing the development of railways during the past seventy years, it appears that, apart from a certain limited number of very high-speed trains, the general speed limit of railways of the present system of constuction is about 65 to 70 miles per hour.

"Higher speed on level runs has undoubtedly been recorded, but it is not probable that anything greatly in excess of 70 miles per hour will be reached until our railway managers initiate an entirely new system of construction. The high-speed service that is now in contemplation, not only in England but in America and Germany, intends to attain speeds of over 100 miles per hour by providing electrical means of haulage sufficient to propel light trains consisting of one, or, at the most a few cars; and in order to render this service successful, to run these light trains at short intervals of time, so in effecting this high speed the railways will give a service which more nearly resembles the tramway service than our present system of heavy express trains at infrequent intervals. This high-speed service of light trains at frequent intervals is well suited to electrical haulage, as it works generating machinery situated at fixed points to the best advantage and enables the best return to be obtained from the necessarily heavy capital cost of copper in the conductors which transmit the energy along the length of the line, as it is evident that if the speed be sufficient to insure that each section of the line only carries one running train, the costs of the conductors will be in proportion to the weight of that train."

Very high speeds, however, can only be used to advantages in cases where the journeys are of sufficient length to make it profitable, and hence this topographical question must naturally place Great Britain at a disadvantage with the Continent and with the United States in respect to high speed systems.

Passing, then, the subject of high speed, Col. Crompton proceeds to consider a most important problem in locomotion, viz., that caused by the congestion of street traffic in our towns, and by the undoubted difficulties which exist in carrying our workers to and from thier homes in the country to their places of employment in our towns.

"A large proportion of the workers who, during the latter half of the last century lived and worked in the country, are now working in towns, although some of them still live outside in order to obtain the advantages of lower rents and of a healthier life for their families, and this last class is likely to largely increase. Those who have been responsible for the enlarging and improvements of our towns have done so much to make town life preferable to country life, that the country is gradually being depopulated. The results we see in the increasing difficulties which the town authorities find in dealing with the water and sewerage questions, and in the increasing mass of vehicular street traffic, which makes some of our cities veritable pandemoniums."

This matter can be helped only in a minor degree by the introduction of tramways, and indeed tramways to a large degree aid in increasing the congestion. In many instances the tramway occupies a portion of a road already too narrow for the demands upon its capacity, while at the same time developing an increase in local population causing still further congestion.

The remedy has been suggested to lie in the use of independent motor vehicles, but these cannot be operated to advantage on existing roads, or indeed on any roads already congested with local traffic. Motor vehicles demand improved roads, and furthermore they demand new roads.

"The increased road and street traffic, and the development of new means of road locomotion, have made imperative some modification of our existing system of roadway administration. Cycles, motor cars, and electrical tramcars have been invented and put on the roads which are maintained and worked exactly as they were seventy years ago at the commencement of the railway era, when the population of the United Kingdom was half its present figure, and that of the large towns one-tenth of the present figure. During the 150 years previous to the railway era the ancient tracks were gradually improved into tolerably efficient roads for coach and wagon traffic; but after the introduction of railways there was a complete cessation of improvement, as for 50 years after the railways started the old roads were equal to the farmers' and local traffic which the railways left for them; but for the last 20 years the roads near to the great towns have been inadequate, and now that the cyclist and motorcarist travel over the whole of the roads of the country, the neglect of our ancient roadway system is very apparent.

"Although the urban populations have so greatly increased, the old coaching roads are still the only ones that exist; no main roads parallel to the old ones, or alternative to them, have ever been made. Towns which are now joined by railways grew out of small rows of houses built facing the main road; in fact, in many cases the road made the town. During the early part of the railway era, when the roads were so little used from coaching falling into disuse, encroachments on the roadway took place in and near the towns, such roads being now actually narrower and less suitable for traffic than in the coaching days; so that these towns which owe their existence to these roadways now put every impediment and hindrance to their use by the travelling public. What is needed is that towns situated on our main through roads should provide alternative routes, so that through travellers could, if they desired, avoid the crowded streets of the town. One method of providing such relief roads would be by by-laws providing that all building estates should set aside land for main roads. The building estates which are developed around our great towns never provide a road which can be used as a main line of thoroughfare, although by their very act of building additional houses they cause additional congestion to the main roads. They lay out their roads to obtain quiet for those who live on the estate, and take every possible means to prevent their estate roads from taking a share of the main thoroughfare traffic."

Given, then, improved roads, together with especial highways for motor vehicles, permitting the rapid speeds of which they are capable, we have a solution of the problem of much of the congestion of the present day. The actual time of running may be slower than that of steam railway trains, but the independent vehicle, starting from one individual location and arriving at the other without change, will in many instances save time in the total length of the journey, while in most cases much will be added to the comfort of the traveller.

Col. Crompton closes his address with a discussion of the importance of standardisation in all departments of engineering work including motor vehicles, and speaks with especial commendation of the establishment of the National Physical Laboratory.

The Adoption of the Metric System.

With the increasing competition for trade in mechanical products with metric using countries there has come a demand for the introduction of the metric system in British workshops, in order that the demands from customers for articles in their own system of dimensions may be met. For this reason the paper of Mr. Arthur Greenwood, upon the adoption of the metric system in British workshops, presented before the Mechanical Section of the Glasgow Congress, demands attention at the present time.

Personally Mr. Greenwood maintains his own experience in international trade has caused him to believe that the adoption of the metric system would aid materially in pushing the sale of British machinery in foreign countries, and he goes so far as to advocate the adoption in England of the metric system in its entirety.

After referring to the many inconsistencies and difficulties of the English system, or lack of system, Mr. Greenwood admits that it is England's privilege, if she so desires, to continue methods which have been condemned by most nations of the earth.

"But," he proceeds, "it may be assumed that the British mechanical engineer cannot afford, and has no desire, to be content with any such position. He is determined to continue the efforts he has up to now successfully made, in spite of what has been lately said and written as to his decadence, to push his manufactures in every market in the world. He has to meet competitors from America, Germany, and France in the countries of Europe and elsewhere where the metric system is universal. Germany has followed the lead of the Latin countries, and has abolished her many standards of feet, and Austria has done the same. Russia continued to honour us for years by using our standards, and still does so to some extent, but in Russia before very long the metric system will be as general as it is in Germany, thanks very largely to German propaganda in that country. If the British mechanical engineer is to hold his own in these markets, it is imperative that he should offer goods to conform to their usages in dimensions and weight. The writer would appeal to those of his engineering colleagues who have doubtless found themselves in the same desperate position he has found himself, provided with a drawing of an elaborate machine carefully scaled to 1 in. or 1½ in. to 1 ft., and with probably a very imperfect knowledge of the language of the country with which he desires to transact business, and endeavouring to answer the numerous questions of an inquisitive and intellectual foreigner who wants to know the dimensions in millimetres and weight in kilograms of particular parts of the machine. Under such circumstances the wonder is that orders could be obtained at all, and considering the disadvantage under which he has shown his wares, success in obtaining orders can only be considered a tribute to excellence of design. True, experience has taught many engaged in Continental trade to have plans drawn to tenth scale, thus somewhat mitigating the difficulty here alluded to, but no one can possibly maintain that the seller's position would not have been wonderfully improved, and his own and his prospective purchaser's temper less sorely tried, had he been provided with drawings in metric scale, and with weights indicated in kilogrammes instead of tons and hundredweights."

Leaving aside the possibility of any change in the metric system at this late date, which might render its introduction easier, the principal objection to the change would be the cost. This, we think, is underrated by Mr. Greenwood, and the real question in that direction is the balancing of the actual cost of the change against the cost of not changing. That trade is lost by not conforming to the desires of metric using countries is doubtless true. This subject was agitated in America about a year ago in connection with the manufacture of screw-cutting lathes for export. It was found that some establishments provided such tools with metric lead-screws, but in most instances a translating change-gear was provided, and the same result accomplished at less cost. When it is understood that all over metric-using countries the Whitworth screw system, with English dimensions, is in general use, and that no one of the fifteen or twenty metric screw-thread systems has come into general use, the urgency of change in this direction may well be questioned.

In America, also, one of the leading firms of machine tool builders, many years ago decided to put this matter to a practical test by equipping one of its departments with metric scales and tools; and produced, and still produces, the articles there made entirely in metric dimensions. After more than forty years the result is that the system has not been extended to other departments, and there is no more consistent opponent of the metric system than this same establishment, although its products go to all parts of the world.

The fact is that no legislation can be introduced which will render the metric system acceptable to the English-speaking world, but at the same time there is little doubt that English and American engineers will gradually be compelled to adopt it, acceptable or no. This will take place by the pressure of trade and not by appeals or argument, and it is to the commercial, and not the sentimental demand that we must look for the change to come. As a matter of fact the engineer cares little about the absolute dimensions of a machine or structure, it is the relative dimensions and the fitness of the design which claim his interested attention. Apart from certain limited parts, those which the user may be called upon to reproduce or replace, and which can readily be made to suit the demand, the dimensions of the rest are immaterial, so long as there is sufficient strength, and excellence of proportion. The true advantage of a decimal system, metric or not, accrues to the designer and computer, and that is in no way due to the metric system, but is caused simply by the accident which gave us 10 as the base of our very imperfect system of arithmetical numeration. It is yet within the bounds of possibility that a notation as far superior to the present as the present was superior to the Roman may come into use, a notation which may render computations of overwhelming difficulty as simple as ordinary arithmetic, and with the fading of the decimal notation the metric system will disappear and be no more seen.

Recent Improvements in French Lighthouses.

The well-known completeness of the French lighthouse service, and the promptness with which improvements are adopted, renders the French coast the best protected in Europe, and for this reason the paper of Baron Quinette de Rochemont, read before the Waterways and Maritime Works section of the Glasgow Congress doubtless represents the latest modern practice.

"One of the chief improvements has been the adoption of *feux éclairs,* or lightning lights. With this new device the maximum efficiency of the illuminating apparatus is obtained; whether the illuminant be oil or electricity, it has given rise to quite a series of new types of appliances used in connection therewith. Again, the luminous efficiency of the optical apparatus has been increased by improving the focal precision, and by keeping the characteristic or effective divergence within narrow limits. The generating stations for electric lighthouses, built until quite recently on old-fashioned lines, have been brought up to date with all modern improvements. The adoption of incandescent burners for compressed gas or petroleum vapour has been a great step in advance. Not only has the intensity of the light been increased, but a light with a wick and ordinary mineral oil can now be made to burn continuously night and day for three months, with only occasional examination at long intervals of time. These permanent lights can have all the characteristics of superintended occulting or flashing lights. The adoption of permanent lights has enabled points of secondary importance to be lighted under economical conditions, and has thus efficiently filled a gap in the system of maritime illumination. Other permanent lights, in the form of illuminated buoys fed with oil-gas, have been adopted on an extensive scale, either to increase the protection at dangerous points and as substitutes for certain lightships, or for lighting winding and shifting channels; also for supplementing the indications afforded by leading lights or sector lights, or for pointing out the position of works in construction at the entrance of harbours."

The lightning flash system is usually employed with electric arc lamps of high power, and is used especially for lighthouses of the first order, and it has been so fully described, both in this magazine and elsewhere, that it need not be discussed at length here.

More recent is the application of incandescent mantles, heated by compressed gas or petroleum vapour.

"Incandescence with low-pressure gas only gives a comparatively feeble intrinsic brightness. Compressed gas must be used in order to obtain a greater intrinsic brightness than that afforded by the largest petroleum burners in use. With compressed gas, the quantity of gas supplied to the mantle, and the rate of combustion, vary in proportion to the pressure; whilst the dimensions of the incandescent light remain unaltered. The temperature of the mantle and its intrinsic brightness are therefore gradually increased. To overcome the objectionable condensation which occurs when coal gas is used, even at low pressures, the Pintsch gas, which is already in use for lighting buoys, has been adopted. This gas can bear a pressure of 10 or 12 kilogrammes (140 lb. to 168 lb.) without condensation, so that it can be stored in small portable reservoirs.

"The necessity of building works for supplying the oil gas has limited the application of incandescent gas lighting to a few important lights. The Lighthouse Department therefore has endeavoured, with success, to obtain the same advantages, for a slight outlay, by substituting petroleum vapour for incandescent lighting. The burners employed are all made on the same principle, but their arrangements differ slightly according to the type of lighting apparatus for which they are intended. This principle consists in injecting the liquid petroleum into a vaporizer, heated by the mantle; the vapour then passes into the Bunsen burner of the mantle, after mixing with the air required for combustion. In starting, the vaporiser is heated by a spirit flame to the required temperature.

"Incandescent gas lighting, when no special gas works are required, is not much more expensive than lighting with a three-wick burner; and even when special works are necessary it is more economical than a five-wick burner. The annual expenditure for gas lighting does not exceed 1800 francs (*72l.*) with gas works, or 800 francs (*32l.*) without works; for petroleum vapour lighting it amounts to 650 francs (*26l.*). These figures show at a glance the advantage, from an economical point of view, of the system of incandescent lighting."

High Speed Electric Traction in Germany.

Among the papers presented before the meeting of the Electrical Section of the Glasgow Congress, was an account of the experiment high-speed electric car which has been constructed by the Allgemeine Electricitäs Gesellschaft for operation at a speed of 200 kilometres per minute on the Berlin-Zossen military railway.

This paper, of which Herr Lasche gives an abstract in *Engineering,* contains an account of the trials which have been made on the testing stand at the factory, and it is expected from these that success will be attained in actual running on the road.

"The problem put before the designer was the creation of something altogether new, namely, the construction of an experimental motor car, outside any existing type of low-speed electric locomotives, or of street railway cars. The only aim in view in making the investigations was the construction of a motor car to run long distances at the highest attainable speed.

"The weight of the electrical equipment in the first design was not less than 50 tons for the required output of 3,000 horse-power, but by modifying the construction of starting apparatus, motors, and transformers, the weight in subsequent designs was reduced to 30 tons. A large proportion of this weight was made up by the transformers, which may possibly be dispensed with altogether in the future.

"A question of the greatest importance was the mechanical connection betweeen the motors and the wheel axles. It was, of course, understood that all intermediate gearing was out of the question owing to its unavoidable wear and tear. Although from the beginning the object was to obtain an elastic connection between the motor and the axle, various designs and constructions were tried; in some the motors were rigidly coupled to the wheel axles, and in others a spring arrangement was provided. The solution of the problem of providing a spring device, to work at about 1,000 revolutions per minute and 750 horse-power per motor, was, of course, extremely difficult, and required a most serious and critical examination of the designs. The problem has been solved by a special arrangement, in which the power developed by the motor is transferred to the wheel by an elastic and sliding coupling, and by an elastic suspension of the motor, which from a soft movement in the beginning turns into a suspension of increasing rigidity. It followed from this arrangement that each motor must have a hollow shaft, and the speed in the bearings is nearly 15 metres (49 ft.) per second. A careful study of the friction at this speed has been made, and experiments also carried out with speeds up to 20 metres (82 ft.) and 25 metres (98 ft.), and with great bearing pressure

"Starting resistances for motors of 250 to 750 horse-power have already been used in practice; but the question of starting resistances for four 750 horse-power motors enclosed in a very narrow space, and for their continual regulation, had never before been contemplated. The individual merits of liquid and metal resistances were considered at length. The use of the former seemed to be out of the question, whereas the latter involve a great number of contacts, brushes, connecting cables, and resistance material, and were consequently too heavy and complicated.

"Four motors, each with three armature circuits, give a total of 12 phases, in each of which was inserted a resistance divided into 12 steps. Notwithstanding this subdivision of the resistances, the difference of the currents was still intense from step to step; and the regulation, done by jerks, was very unsatisfactory. The difficulty was overcome by the design of a patent starting resistance, such as can also be used for large winding engines.

"Although the resistance material here is a solution of soda, this apparatus has nothing in common with the ordinary liquid starting resistance—a fact which has been proved by trials made on a large scale."

The discussion brought out some very strong opinions as to the difference with which advance in electric traction was encouraged in England and Germany. In Germany the Emperor threw all his powerful influence to the development and advancement of the application of electric driving to high-speed traction, while in England, as in the case of the proposed Manchester-Liverpool line, opposition from authority was the order of the day. Ultimately it is to be hoped that broader views and greater encouragement to progress will prevail at home, but at present it appears as if the greatest hindrances to electrical development in Great Britain are found in her own officials whose methods of "how not to do it" have long outlived the attacks of Dickens.

The Commercial Organisation of Shipyards.

It is now generally recognized that there is no standard system of works organisation and management, but that different systems must of necessity be devised to meet the requirements of the many and varied kinds of establishments in operation. It is, however, possible to consider the general principles which apply to works, of any given class, leaving minor details to be worked out in each instance as experience may indicate.

The paper by Mr. Walter Scott, recently presented before the North-End Coast Institution of Engineers and Shipbuilders, examines the general principles involved in the commercial organisation of shipyards, and gives some features which are of permanent value and interest.

Passing over the question of correspondence, which demands systematic and prompt attention, the questions of estimating and buying are taken up.

Estimating is a matter of much importance, especially when it is necessary to compete for work in the open market. To make a satisfactory estimate one must be able to form beforehand a close estimate of what the work will cost under normal conditions. With this as a basis, there is play for business abilities for judgment, or knowledge of the market and of the customer. A vessel is a large and complex structure, and a small error in estimating may amount to a large sum. In order to avoid the fruitful error of omitting something, printed estimating sheets should be used, with the details grouped so that the approximate cost of a vessel based on main headings may be quickly made up. This permits an estimate to be prepared promptly for a reply by the same day's post, or even by wire, without the risk of making some important omission, since any item missing on the sheet would at once be detected.

The question of buying is closely connected with that of estimating, since one must have a full knowledge of the current market prices of materials. Much material may be purchased on yearly, or half-yearly contracts, this applying especially to such stock supplies as paints, rivets, bolts and nuts, and the like. Materials such as steel, iron, and wood are generally purchased in quantities, and there is much scope for business acumen in arranging to contract ahead on a rising market to avoiding doing so when it is falling.

The matter of cost-keeping, as Mr. Scott observes, is of sufficient importance to demand an entire paper by itself, and can only be dealt with generally.

"All the costs should be kept in grouped detail, and arranged in precisely the same order as the estimate sheets; they must not on any account be allowed to run into ar rears. In a well organised office is should be possible to see the cost of any vessel to date at least each month, or even each fortnight, and that, too, at a period only two or three days after the date the cost is made up to. This is not a difficult matter, neither does it necessarilv involve a very large staff, whilst its importance is paramount both for estimating purposes and as a check on the cost of construction."

The important item of establishment charges Mr. Scott divides into two classes, the one covering the details of office expense, and the other the non-productive establishment charges, such as rent, rates, depreciation, upkeep, etc.

There are several methods of allocating the proportion fairly chargeable to each job; but the following is recommended:

Office expense, etc.—charged to each ship in proportion to the wages paid.

Rent, rates, etc.—in proportion to the tonnage of each vessel.

Depreciation—in proportion to wages paid.

Gas, oil, etc.—in proportion to wages, but corrected for the time of year.

Coal, etc.—in proportion to the number of tons of iron or steel worked into ship.

Smithy coal—in proportion to number of tons weight of smith work turned out.

All wages cost should be divided up so as to show the amount expended on any one job by each separate trade, piece-work and time-labour being kept separate. Returns of piece-work should be made every week, and the returns may be plotted to show a curve.

The object should be to enable the principal to keep in close touch, while at the same time avoiding too much centralisation, or he will be worried with details, and his time too much taken up to enable him to give the important points of the business the attention which it requires. At the same time close touch must be kept, or serious leakages will occur.

REVIEW OF THE CONTINENTAL PRESS

Alcohol Motors.

In view of the numerous questions which have arisen as to the advantageous use of alcohol in the arts, as an outlet for the increasing quantity manufactured, the exhaustive study of its use as a source of motive power, presented before the *Société de Ingénieure Civils de France* by M. Lucien Périssé, and published in the *Mémoires* of the Society is an important paper demanding examination and review.

Alcohol is especially a French product, and both at home and in the colonies it forms an important element in agricultural science. Recently the crisis in economics in certain agricultural districts in France, has rendered it most desirable that the engineer should come to the rescue by providing a suitable outlet for the product, and hence the paper of M. Périssé is especially timely and valuable. Ordinary ethylic alcohol produces 324.5 calories per kilogramme, and requires at least 7 kilogrammes of air for its combustion. When there is an excess of oxygen present, there is produced by the combustion only carbonic acid and vapour of water, but with a limited supply of air aldehyde is produced, this being then converted into acetic acid. This fact renders it desirable that an excess of oxygen should be present during combustion, in order that the formation of corrosive compounds may be prevented. The action of alcohol itself renders it necessary that carburetters be made of bronze and nickel, to the exclusion of iron and aluminum.

For practical use a 90 per cent. alcohol is readily available, and in order to avoid the possibility of its use as an intoxicant, it is subjected to a process of "denaturation," this being accomplished by the addition of methylene and heavy benzine. In order to increase the calorific power the alcohol may be carburetted by the addition of ordinary light benzine, from 25 to 50 per cent. of the latter being added. M. Périssé discusses at length the various methods of carburetting alcohol, giving a comparative table of different mixtures and their calorific values.

Passing over the legal questions examined by M. Périssé in connection with the use of alcohol in France, we proceed to its use in the generation of motive power. Like other light hydrocarbons is first vaporised in a so-called carburetter, and the vapor then used in some form of internal combustion motor.

Nearly all the engines in which alcohol is used are four-cycle motors of the Beau-de-Rochas type, although it has also been employed as a fuel for small steam motors, this application, however, being very limited. Generally speaking the use of alcohol as a source of power involves two distinct pieces of apparatus; the carburetter, or generator of the explosive mixture, and the transformer of energy, or motor properly so-called. Although both carburetters and motors have been given much study, especially in France, the peculiar requirements of alcohol as a fuel have not been given particular consideration, and the same is true of motors.

The function of the carburetter is the vaporisation of the fuel and its mixture with the proper proportion of air for the most effective combustion in the cylinder. Carburetters may be divided into four types: those which act by contact of the liquid fuel with heated surfaces; those which act by the pulverisation of the liquid in a current of air; those in which it is fed in small drops; and those in which the vaporisation is effected in a chamber heated by the explosions, this hot chamber serving also as a method of ignition.

In order that the alcohol shall be completely vapourised it should be heated to not less than 100°C., and this heat may be supplied in various ways. The most general system is that which employs the heat of the exhaust gases from the cylinder, either directly or partially, and in some cases the waste heat from the ignition lamp is found sufficient. When the vaporisation is effected by a jet of air and an atomizer, the air is previously heated; heated air being also used when the fuel is supplied by a drop feed. When a heated combustion chamber forms a part of the motor, no heating is necessary in the carburetter, it only being necessary to insure a proper mingling of the fuel and the air. M. Périssé describes a number of carburetters of various designs, and calls attention to the importance of a correct regulation of the feed of the liquid fuel and the air. M. Périssé describes a designed for use with other liquid hydro carbons, and in practice those which act by pulverising the fuel in a jet of hot air, are found to give satisfactory results with alcohol. The feed is usually controlled by a float in an auxiliary reservoir.

In nearly all the experiments which have been made the motors used were originally intended for gas or gasoline, there having been but one alcohol motor shown at Vincennes in 1900. Data and results of a number of tests of such motors operated with various combinations of alcohol and benzine, are given by M. Périssé, showing that even with motors not especiallly proportioned for use with alcohol gave a thermal efficiency practically the same as with gasoline, so that the cost of power depends upon the commercial price of alcohol.

In designing a motor expressly for use with alcohol the principal points to be observed are that the stroke should be long and the compression high. The ordinary gas and petroleum engines are frequently made "square," as it is termed, the stroke and the bore of the cylinder being equal to each other. A more complete combustion, and a fuller utilisation of the effect of the explosion is obtained with a stroke of 1.75 to 2.2 times the bore. So far as the compression is concerned, it is a general law of internal combustion motors that the compression should vary inversely as the calorific power of the fuel. The exact degree of compression desirable for alcohol, or for mixtures of alcohol and gasoline, has not yet been accurately determined, but the advantages of high compression, both for economical working and for lowering the temperature of ignition have been plainly shown.

In view of the fact that a large part of the market price of alcohol is due to legislation and not to actual cost of manufacture, it is most desirable that with the technical development of its application to motive power there should be a scientific demonstration of the industrial advantages to be gained by directing this important product into a new field of consumption. This M. Périssé has done for France, and should the result prove of technical and commercial advantage there, other countries will not be slow to follow.

Power Development in Navigable Streams.

In the great majority of cases in which the power of a stream is utilised, a permanent dam is erected, and the entire flow is controlled for motive power. Many variable streams, however, are made navigable by the use of movable dams, and in such cases there is a greater or less quantity of hydraulic energy available, although this is usually permitted to run to waste.

At the dam at Poses, on the Seine, near Amfreville, in the Department of the Eure, however, there is an interesting combination of locks, movable dam, and power station, of which a description is given in a recent issue of *Le Génie Civil*, and from this some features of interest are abstracted.

The river Seine is divided at Poses into two branches, the main arm containing the movable dam, or barrage, while the narrow branch forms the navigable portion, containing the locks and a small needle weir. The normal difference in level at this point is 4.18 metres, or 13.71 feet, the flow varying from 100 metres at exertme low water to more than 1,800 metres in time of flood. The power thus varies from 0 to 22,000 horse power, with a mean development of about 13,255 horse power for about six months in the year.

The power house, which in this case is small, is placed on a pier between the two locks which occupy the small arm of the river, a most convenient location, as the masonry required is but little more than would be necessary for the pier, and the channel for the flow of water is the shortest and most direct possible.

As the power is at present used only for the manipulation of the lock gates and the movable dam, a turbine of 30 h. p. has been found sufficiently large for the service, this being placed in a pit beneath the pier, leaving the main floor of the house for the electrical machinery. A pair of bevel gears transmit the power to a horizontal shaft from which the two dynamos, of the Gramme type are belted, these being of 40 amperes and 275 volts each. The general electrical details call for no especial mention, but the mechanism for the operation of the dam are of interest. The dam itself is of the Caméré type, with rolling curtains supported upon vertical frames hinged to a girder bridge above. The opening is obtained by first rolling up the curtains by winding up the chains passing beneath them and then lifting the frames by swinging them up upon their upper hinges.

As originally constructed, the winding of the curtains was effected by hand windlasses, this requiring four men to a windlass and necessitating arrangements for the men to go out upon the frames in midstream. These hand windlasses have been replaced by electrically operated machines, this enabling a prompt control to be obtained with a small number of operatives, two men, one upon each bank having entire control of the whole dam. When it is understood that the dam is 235.2 metres in length between abutments, and that there are 100 curtains, each curtain, with its chains, weighing 911 kilogrammes, it will be realised the magnitude of the operation. Although the speed of opening or closing is necessarily limited by the conditions of the flow of water in the river, a general gain in speed of more than 40 per cent. is secured by the use of electric power, and when it is considered that the energy is supplied entirely by the force of the river itself, the economy is apparent.

In addition to the suplpy of motive power for the manipulation of the dam, the power house furnishes current for lighting the works, this in itself contributing greatly to the convenient management of the plant. The total cost of the installation was less than 2 per cent. of the original cost of the dam, and would have been materially less had it been introduced at the time of the original construction of the works.

The employment of the force of a stream for the manipulation and control of its own regulating machinery possesses many advantages, especially for large installations, and notwithstanding the frequent and extensive variations in available head of water there is always power enough for practical service, especially when, as in the plant at Poses, there is installed an accumulator of sufficient size to equalise the loads. Although this plant is small, the excellent judgment which has been shown in its arrangement renders it especially worthy of mention and it will doubtless serve as a model for others.

Electric Plants in Germany.

It has been the practice of the *Elektrotechnische Zeitschrift* for a number of years to give an auual résumé of the statistics of electric generating stations in Germany, and these show in an interesting manner the development of electrical industry from year to year. Such statistics necessarily cover only public generating stations, it being impossible to secure data of the numerous isolated plants in operation; but the data of the public stations give an index to the growth of the electrical industry at large, and, when analysed, show the progress of various systems and methods.

At the present time there are in the German Empire 768 electric generating stations, of which 116 have been started since March 1900. In this number there are several groups of stations which are considered as single establishments, being operated in connection under the same control, the 768 stations representing 749 different localities. The data concerning all these stations are tabulated in such a manner as to show the system, magnitude, applications, and capitalisation, the whole forming a most complete exhibit of this important industry. For details the reader must be referred to these tabulated sheets, but some abstracts concerning the more important installations may be here given.

There are in Germany 33 cities of more than 100,000 population, and all of these, with one exception, possess electric generating stations, and in the city of Kiel, the exception referred to, a station is under construction and nearly completed. Considering the more important of these, classified according to the output of electrical energy, the largest are the two great stations in Berlin the Oberspree, which, with its substations, has an output of 22,075 kilowatts, and the Moabit, with 19,494 kilowatts, there being also five other stations in Berlin, ranging from 2,800 to 10,000 kilowatts. The great hydro-electric station at Rheinfelden comes next with 12,360 kilowatts, followed closely by Munich, with 11,300 kilowatts; while the total number of stations of more than 2,000 kilowatts output reaches thirty-eight, with a total of 192,055 kilowatts output, the remaining 730 stations aggregating only 160,515 kilowatts.

It is interesting to note the rapid proportional increase in the use of polyphase currents. Thus in 1900 there were 524 stations generating continuous current, with an output of 123,709 kilowatts; while in 1901 the number of stations has risen to 624, with a product of 172,949 kilowatts, and increase in stations of 19 per cent. and in output of 40 per cent. For polyphase current, however, the number of stations has risen from 39 to 45, and the output from 35,677 to 41,634 kilowatts. This latter is a small increase, but the number of stations generating both polyphase and continuous current has risen from 38 to 43, with an increase in output from 46,608 to 102,511 kilowatts, a gain in product of 120 per cent.

Another interesting feature is the general introduction of accumulators in central and distributing stations. Practically all the sations generating continuous current are equipped with accumulators, and for electric lighting especially this method of equalising the load has been widely adopted.

By far the greater number of stations in Germany are operated by steam power. Of the 768 stations, 463 are driven by steam power, these aggregating an output of 168,314 kilowatts, while 73 are hydro electric stations, generating 15,354 kilowatts, 12,000 kilowatts being the nominal output of the great station at Rheinfelden. The remaining stations are operated either with mixed water and steam power, or by gas, or other internal-combustion motors.

The tabulated statement of the growth of the industry since 1888 shows that the average increase has been more than 100 stations per year, for the past four years, while at the present time there are 90 stations under construction and projected.

A popular conception of the total amount of electrical energy generated at the present time in the German Empire may be given by reducing the total to an equivalent in 16-candle-power incandescent lamps. Reckoning an arc lamp as equivalent to 10 incandescent lamps, and 1 horse-power as equal to 18 lamps, the lamps being assumed to consume 50 watts each, the output of the public stations is capable of supplying 6,591,437 16-candle-power lamps, as against an equivalent of 5,039,217 lamps for the preceding year. This is equal to about 280,000 horse power, or about three times the amount of power now being taken from Niagara Falls.

Hydraulic Propulsion.

Jet propulsion has been a subject of discussion for a long time, and although numerous unsuccessful experiments have been made, it still remains a fertile field for investigation and study.

A very thorough examination of the whole subject, both historical and practical appears in a recent issue of the *Revue de Mécanique*, by M. Marchand Bey, who, from his extensive experience in the construction and operation of centrifugal machinery and hydraulics, is well equipped to discuss it.

The earliest recorded mention of the idea of propelling a boat by the reaction of a discharged jet of water appears to have been due to Daniel Bernouilli about 1730, and he appears to have made some experiments without achieving any noteworthy results. Early and unimportant experiments were also made by Rumsey in 1784, and by Watt, after which the subject dropped out of sight until the important experiments by the British Admiralty in 1866 with the "Water-Witch," built by Ruthven. More recent experiments have been made by Fleischer, Thornycroft, Jackson, Zeuner, and others.

After quoting from Bernouilli and from Rankine that theoretically the propulsion of a vessel by a jet of water should be the nearest to perfection, M. Marchand proceeds to examine the discharge of liquids according to the principle of Torricelli. Considering fixed jets, he first computes the forces of discharge according to the well-known formula of falling bodies, and then applies this to the impact of the jet against a moving body. From this the work effected may be computed, as well as the velocity of the body impelled by the jet. Extending this investigation to the action of a submerged jet, the conditions are obtained for application to the problem of the propelling effect of a jet issuing from the stern of a boat.

A portion of the effort of the jet acts against the frictional resistance of the periphery of the issuing jet upon the body of water into which it is discharged, a portion of it is exerted in agitating the water, and in general the resistance which it encounters forms the reaction which is available for the propulsion if the boat. In this respect the jet does differ materially from the mass of water impelled by the ordinary screw propeller, and indeed the observer looking aft from a modern fast steamer can distinctly observe the jet of water driven back by the propeller and rising to the surface hundreds of yards astern.

Having examined the jet, M. Marchand discusses the resistance to the advance motion of the boat, this resistance being equated against the reaction of the jet to determine the propulsive effect.

He thus deduces formulas which are so general as to be applicable to any special case, and then proceeds to show by examples how they may be used.

The important question in hydraulic propulsion is the production of the jet. As already observed, the ordinary screw propeller is really a form of jet propeller, and various attempts have been made to increase its efficiency by inclosing the propeller-wheel in a tube or casing, thus converting it into a form of turbine or propeller pump. It is really this form of pump which is advocated by M. Marchand, the pump being constructed within the hull of the boat, drawing the water from beneath the keel and discharging it aft through a tube.

According to the formulas deduced by M. Marchand, the propulsive efficiency of a jet should theoretically reach 94 per cent., and since an efficiency of a screw-propeller pump can attain 80 per cent., it appears that a joint efficiency of 0.75 per cent. should be reached by the combination.

An important feature of hydraulic jet propulsion as compared with the screw propeller lies in the fact that the efficiency is the same for all speeds. This practical fact bears out the theory of Bernouilli and Rankine, while according to Collignon, screw propulsion is defective in that the apparatus commmunicates to the water velocities not only parallel and oppposite to the direction of motion of the boat, but also velocities normal to that direction. These normal components being entirely without influence upon the propulsion, an important portion of the living force of the water is entirely lost.

Discussing the important influence of currents in the stream upon jet propulsion, M. Marchand shows that both in going with, and against a currrent, there is required a definite excess of discharge over that demanded in still water, and deduces formulas from which this excess may be computed.

A very interesting portion of the paper consists of a tabulated account of the character and results of the work of previous experimenters, from Rumsey, in 1784, down to the present time. This table shows the intimate acquaintance of the author with the present state of the subject, and adds meterially to the value of his deductions.

M. Marchand concludes his paper with practical applications of a number of his formulas to examples showing the manner of their use, giving their general character for vessels of any size.

This scientific examination of a question which has been too generally treated in an empirical manner, is most welcome, and should do much to redeem the dubious method of jet propulsion from the discredit which has until now attached to it. Practically all methods of mechanical propulsion depend upon the reaction of a mass of water impelled backward by the propelling mechanism, and with sufficient data given, there is no reason why every branch of the problem should not be examined mathematically and rationally, the empirical element entering only in the case of insufficient data.

A Year's Work on the Simplon Tunnel.

We have given from time to time abstracts of the quarterly reports upon the great engineering work of the piercing of the Alps at the Simplon Pass, and now we have a general review of the work for the year from January, 1900, to January, 1901, given in recent issues of the *Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines.* This abstract, by Herr Wagner, discusses the geological formations as revealed by the work, as well as the phenomena of the rise of temperature, and considers in detail matters of execution and cost in a most instructive manner.

A general account of the tunnel was given in a review in the issue of this MAGAZINE in August, 1889, but some few leading facts may here be repeated in order to emphasise the report of the progress for the past year. The total length is to be 64,735 feet, or 12.26 miles, nearly 3 miles longer than the St. Gotthard tunnel, but at a lower level than the latter, being only about 2,300 feet above the sea level.

The plan includes the construction of one main tunnel of sufficient width for single track, and of a parallel tunnel of smaller cross section, capable of being enlarged later to full size for a second track. The main tunnel is connected to the auxiliary tunnel by cross cuttings spaced 650 feet apart, exhaust fans connected to the latter enabling complete ventilation to be secured. When the two tunnels are finally completed there will have been much less rock removed than would have been necessary for, a single double gauge tunnel and the cost of the work is distributed over a longer period. The work, which was begun in 1898, was expected to be completed in five and one-half years, and up to the present time the rate of progress has exceeded the estimates.

At the close of December, 1900, there had been completed in the main tunnel a length of 23,842 feet, or about 4½ miles, nearly 37 per cent. of the whole length. The progress during the year 1900 was 11,158 feet, of which 5,968 was the penetration on Swiss side, and 5,190 feet the advance on the Italian side. As this rate is materially greater than was allowed in the original estimate, there is every probability that the work will be completed within the proposed time.

The geology of the tunnel as revealed so far is of interest. On the Swiss side for nearly 2½ miles the rock is a gray slaty limestone, with a strata of granular chalk, containing black mica. Further penetration enters a micaceous dolomite with layers of gneiss, there being numerous small streams of water trickling through the seams.

On the Italian side the formation is similar to the northern portion, the micaceous gneiss containing quartz nodules and crystals of white feldspar, there being less water than on the Swiss side.

One of the most interesting features of the work has been the temperature of the workings. These have been taken regularly, thermometers having been inserted in holes bored about four feet deep in advance of the workings, in order to ascertain the true temperatures of the rock itself. Although the borings have been practically horizontal, the temperatures have steadily increased. At 500 metres the average temperature was about 13 C.; at 1,000 metres this had risen to 16 C.; and at 2,000 metres, 20 C. Borings made when the penetration into the side of the mountain had reached 3,664 metres gave a rock temperature of 28.5° C. on the Swiss side, while similar tests on the Italian side at a penetration of 2,800 metres gave 31° C., or about 88° F.

With progress of the work there has been gained a familiarity with the operations which has facilitated both the speed and the economy. In the earlier operations it required more than 4 kilogrammes of dynamite for the removal of a cubic metre of rock, while during 1900 the consumption of dynamite per cubic metre of rock removed from 1.70 to 2.00 kilogrammes, a notable advance in economy. The rapid progress of the work may be seen when it is understood that the original rate in the engineers' estimate for the close of 1900 was 6,487 metres, or about four miles, while in fact the penetration at that date was 7,267 metres, or 4½ miles.

Since the publication of the report for 1900 there have appeared the first and second quarterly reports for 1901, showing the progress made up to the middle of the present year. At the close of March the penetration in the main tunnel on the Swiss side had reached 4,963 metres and on the Italian side 3,610 metres, a total of 8,303 metres, or 5.16 miles, while at the close of June, 1901, the penetrations were, on the Swiss side, 5,195 metres, and on the

Italian side, 3,977 metres, a total of 9,172 metres, or 5.70 miles. At these depths the rock temperatures reach 34° C., or about 93° F.

The energy with which this great work is being pushed is a remarkable tribute to the progress which has been made in the application of mechanical appliances to engineering work. The Brandt hydraulic drills, which have been used for a large part of the work and which were the invention of the deceased chief engineer of the tunnel, have been most efficient, while the applications of hydraulic power and electric driving have been a marked aid to the rapid progress of the work. The auxiliary tunnel has been an efficient outlet for the removal of rock and debris, enabling the masonry work upon the main tunnel to be pushed with the utmost despatch, and the whole organisation of the work has shown the value of system and method.

When the tunnel is completed it will afford direct communication between the Rhone valley and northern Italy, and will materially shorten communication between Milan and ports on the North Sea, thus enabling the Jura-Simplon railway to become a most formidable rival to the St. Gothard and Mont Cenis routes for the commerce between Italy and Eastern Europe and England and America.

Modern Turbine Installations.

With the development of the electrical transmission of power has come a corresponding revival in the development of water power, and the design and construction of turbines for use in connection with large electrical generating units has assumed much greater importance as a department of mechanical engineering than formerly. As a natural consequence of the absence of coal and the presence of many sources of water power, Switzerland has risen to eminence in the construction of turbines, and hence a recent paper in the *Zeitschrift des Vereines deutscher Ingenieure* upon recent turbine plants, describing important installations by the well-known firm of Escher, Wyss & Co., of Zürich, contains much of interest.

Although modern turbine design has reached a high degree of perfection in Switzerland, the type generally adopted for low and medium heads is based on the American design of Francis, with circumferential inlet and axial discharge. This type has almost entirely replaced the Jonval turbine, and in many instances is also displacing the Girard turbine, the latter being used only for very large units. For units of moderate discharge outlet working under high-pressure, a direct pressure turbine of the Pelton type with spoon-shaped buckets is employed, these three types forming practically all in general use in new installations.

The large installations lately equipped, being of medium head, have been supplied with turbines of the Francis type,, and its good qualities have been fully demonstrated. It is especially well adapted to close regulation, since by dividing the buckets into sections it is possible to have the ring-gates cut off or open up whole sections when necessary, and thus permit nearly as high an efficiency at part gate as at full gate. Thus, at the paper works on the Sihl an efficiency of 86 per cent. is obtained from ¾ to full gate, while at half gate it falls only to 82 per cent., and at ¼ gate an efficiency of 78 per cent. is maintained.

An interesting instance of the replacement of Jonval by Francis turbines is found in the power house at Schaffhausen, above the Falls of the Rhine. Here three Jonval turbines have been superseded by two Francis turbines of greater capacity and higher efficiency, the same walls and foundations being utilised. Here the head of water ranges between 3.8 to 4.5 metres, and the new wheels were to generate 350 horse power each, as against 200 to 260 horse power for the older ones. Under test the Francis turbines exceeded their nominal capacity rating by 80 horse power, with efficiencies ranging from 86.6 per cent. at full gate to 77 per cent. at half gate.

The new installation at Chèvres, near Geneva, is an instance of the installation of a special type of outward discharge turbine in the face of experience with the conical variation of the Jonval turbine. Here 10 double turbines of 900 to 1,200 horse power capacity have been installed, and although the head varies between 4.3 and 8.1 metres an excellent regulation is obtained. An interesting feature of the turbines at Chèvres is the manner in which the pressure on the step of the vertical shafts has been controlled. In the case of the old wheels there was a heavy pressure on the shaft step, which was relieved by an oil pressure of 15 atmospheres beneath the bearing. In the case of the new turbines this high pressure is avoided. There are two double wheels on each vertical shaft, the lower pair alone operating when the head is high, there being four sets of guide buckets, arranged above and below each double wheel.

In either case the pressure of the water acts partly in opposition to the action of gravity, so that the pressure on the step is reduced to a quantity which can readily be taken care of by an ordinary ring and collar thrust bearing, without requiring any oil-pressure. The special form of centrifugal turbine adopted at Chèvres was chosen because it was desired to obtain as high a rotative speed as possible with a moderate head of water. These wheels are set in a housing of reinforced concrete, a construction which is coming into very general use for such work, for which it offers many advantages.

Another important plant is that recently equipped at Lyons, this constituting the largest hydraulic power plant in Europe; 22,000 horse power being taken from the water of the Rhone. The water is taken from the Rhone above the city of Lyons and conducted through a canal 16 kilometers in length to the power house near Cusset, by means of which a head of 10 to 12 metres is obtained, the water being returned to the Rhone by a tail-race canal 2.6 kilometres in length. Between the ninth and eleventh kilometres of the canal the topography of the ground is such as to form a natural reservoir for the storage of water, this also serving to maintain a fairly constant level of water in the canal.

The power house is being equipped with turbines of the Francis type, there being now installed 8 of 1,250 horse power, 3 of 250 horse power, and 2 of 1,500 horse power, while 6 additional wheels of 1,500 horse power are now under construction.

Each vertical turbine shaft is directly connected to a polyphase generator by Brown, Boveri & Co., of Baden, Switzerland. Each turbine is in a separate cast iron housing and has its own intake pipe, with independent bell vale, in addition to the regulating gates so that the water may be shut off entirely when necessary, the regulating gates being operated by auxiliary hydraulic motors controlled by differential centrifugal governers.

In addition to these impirtant hydro-electric installations in Switzerland and France, a very full description is given of the new turbines for the extension of the Niagara Falls plant. It will be remembered that the original turbines at Niagara, of 5,000 horse power each, were built in America from designs made by Faesch & Picard (now Picard, Pictet & Co.) of Geneva. In the extension of the plant the wheels have been designed by Escher, Wyss & Co., and contain the improvements which have been suggested by the experience with the first installation. By the addition of draft tubes an increase in head is obtained so that 5,500 horse power is obtained from each wheel, with a speed of 250 revolutions per minute, and a higher degree of efficiency is also expected. Instead of double turbines, as in the earlier plant, single Francis wheels are used, the vertical pressure being carried on a counter-pressure piston, in connection with a ring and collar thrust bearing. The governor details have also been modified.

A brief account is also given of the plant at Kubel, near St. Gall, where a fall of 90 metres, with a volume of 4 cubic metres per second. At present there are four wheels of the Pelton type, with spoon-shaped blades, each wheel being of 500 horse power, the fall being capable of extension to about 3,500 horse power. The turbines are directly connected to polyphase generators by Lahmeyer & Co., and furnish light and power to the surrounding neighborhood. A similar plant is now being completed at Flums, for the production of calcium carbide.

This general account of the recent progress which has been made in Switzerland, shows that the country has well maintained its high reputation in that especial branch of engineering, while at the same time its constructors have sufficient breadth of view to adopt all that is good from the practice of other lands.

REVIEW OF THE AMERICAN PRESS

Long-Distance Electric Transmission.

Attention has been frequently called in these columns to the tremendous development in water power by reason of the possibilities of the electric transmission of energy to distant points, and the limitations have been shown to rest upon the electric transmission and not upon the generating plant. It is, however, exceedingly unsafe to dogmatize upon the limitations of any branch of engineering, but although the maximum distance has never been positively stated, it has generally been supposed that the San Bernardino-Los Angeles transmission of 80 miles, in California, would long hold the record.

We have now the transmission from the Yuba river to Oakland, also in California, a distance of 142 miles, while with the current delivered to San Jose, the total length of this remarkable transmission of 184 miles, or more than double that of the San Bernardino-Los Angeles line.

From a very complete account of this latest feat in long distance electric transmission, written by Mr. J. D. Galloway, and published in *Engineering News,* we abstract the following account, referring the interested reader to the original paper for fuller details.

"The power stations are situated in the Sierra Nevada mountains, there being three houses on various forks of the Yuba river, the power thus generated being controlled by the Bay Counties Power Company, and much of it transmitted to Nevada City, Marysville, and Oroville over distance of 20 to 30 miles.

"The plant which supplies power to the Oakland line is located at Colgate, about 36 miles from Marysville, the river being at this point about 600 ft. above sea level.

"The dam across the Yuba River is of timber crib construction, 40 ft. high at the deepest point and about 250 ft. wide on the crest. The controlling gates are set in rubble masonry. In winter the water sometimes reaches a depth of 10 ft. over the crest, and the bed of the river has filled up entirely above the dam with gravel.

"The distance from the dam to the penstock on the mountain above the powerhouse is seven and three-quarter miles. The flume which carries the water from the dam to the penstock has a uniform section, 7 ft. wide and 6 ft. deep. The bottom and sides are of 1½-in. plank, with 4 x 6-in. posts and 4 x 8-in. sills, the bents being 3 ft. c. to c. The grade of the flume is 13 ft to the mile and about 8,000,000 ft., b. m., of lumber was used in the construction. This work, while difficult in places, offers nothing unusual in the way of flume construction.

"The penstock is built of rubble masonry, with a lining of concrete 1 ft. thick. The gates to the pipes are inside the penstock, while manhole pipes, protected with conical hoods, are placed just outside. The penstock is arranged to accommodate five lines of pipe, but at present there are but four lines in place. From the penstock to the power-house the distance along the slope is 1,760 ft., the static head in the pipes being 715 ft., and the average angle of slope about 24° from the horizontal. The contour of the pipe is, however, somewhat irregular, being considerably steeper in parts.

"The upper 800 ft. of the pipes is built of riveted sheet steel, the thicknesses being No. 12, No. 10 and No. 7, in about even amounts. The lower 960 ft. of the pipe is of cast iron, varying from 1 in. to 1¾ ins. in thickness.

"Commercial shapes were used, the lengths being 12 ft. When the pipe passed over bed rock it was anchored with steel straps, and at other places it was set in masses of concrete.

"The pipes, of which there are four, are each 30 ins. inside diameter, and the effective head of water is 695 ft. The flow is at the rate of 8 ft. per second, with a pressure at the receiver of 300 lbs. per sq. in.

"The water wheels were made by the Risdon Iron & Locomotive Works, of San Francisco, and are the common type of tangential water wheels. Each generator is driven by a water wheel mounted on the same shaft. The water from the pipe lines enters a receiving pipe, which lies parallel with the power-house and is taken from the receiver in 14-in. pipes to the water wheels. At present the generators for the Oakland line are controlled by hand, but Lombard oil governors are to be installed."

One of the points which has been assumed to control the length of long-distance transmission lines is the permissible voltage, it being generally considered that pressures of 25,000 to 30,000 could not be commercially exceeded. For the distance between Yuba and Oakland, however, much higher voltages are successfully used.

At the station at Colgates there are six generators, directly connected to the water wheels, these being 60-cycle, 2,400-volt, inductor machines, the pressure being raised by step-up transformers with winding arranged to give 40,000, 50,000, and 60,000 volts. At the Nevada power house, and at the Brown's Valley power house, are other plants, which, while primarily intended for for the local supply can be called upon to supplement the long-distance transmission in case of emergency.

"The line from the power house at Colgate to Oakland, as before noted, is somewhat more than 142 miles in length. At present the line voltage is 40,000, but this will be increrased to 60,000 volts under increased load. At Oakland the current is transformed to 2,000 volts, this current operating three synchronous motors, direct-connected to 550 volt continuous-current generators of 450 k. each.

"The pole line for the entire distance is in duplicate, the two lines of poles being in general about 25 ft. apart. This duplication was made as an insurance against interruption of the service by accident. One line is of No. 00 medium hard-drawn copper throughout, while the other line is of aluminum from Colgate to Suisun, and of copper for the remaining distance. This was done to avoid the corroding effect of the salt air on the aluminum, in the vicinity of San Francisco Bay. The aluminum cable is composed of seven strands of wire having in total the conductivity of No. 00 copper wire, and was made by the Pittsburg Reduction Co. The standard distance from pole to pole is 132 ft."

The most remarkable feature of the entire transmission line is the crossing of Carquinez straits in the upper part of San Francisco bay.

"Since the high voltage carried on the line prohibited a crossing below the water at that pressure, it became a question of either installing transformer stations on both sides of the Straits to first step down the voltage by transformers and then after its passage under the river, to step it up again; or to carry the wire across the Straits as an overhead crossing. The danger to cables lying in the bed of a swift river frequented by large ships, the cost of the transformer stations and the constant loss due to the two transformations led to the adoption of the overhead system, although there was no precedent for determining the behavior of cables of such a long span in a heavy wind."

The details of this remarkable crossing are given very fully in Mr. Galloway's paper, but it may be stated that the main span of the cables is 4,427 feet, with a deflection of 227 feet from the highest elevation; this giving a clearance of 208 feet above the water at the lowest point of the wire.

At the present time about 2,000 k. w. is being delivered over the 142 miles between Colgate and Oakland, and the operation appears to be satisfactory both from a technical and commercial point of view.

The Chicago River.

Ever since the opening of the Chicago main drainage channel there has been much discussion about the conflicting questions of the current and the sewage discharge of the Chicago river, comment having been made upon the subject already in these columns.

These questions have been still further discussed at a recent meeting of the Western Society of Engineers, the occasion being the presentation, by Mr. J. J. Johnston, of a paper upon the Chicago river, published in the *Journal* of the society.

The greater portion of Mr. Johnston's

paper is devoted to the problem of the disposal of the sewage of Chicago, and of the necessary flow required for its proper and safe dilution. Since the opening of the drainage channel the current has been diverted from Lake Michigan through the river and canal, and the lake front has been practically free from pollution. This, however, has been accomplished by the production of such a current in the river as materially to interfere with navigation. Hence the conflicting interests, and so far as the society is concerned, the conflicting discussion, for, in some respects, the various members who took part made things exceedingly interesting for each other.

Apart from the personalities which unfortunately appeared, the whole subject is most interesting, and reveals the difficulties which often arise from a divided authority and responsibility. The Chicago drainage canal is a most remarkable engineering work, and has attracted attention and demanded admiration from the entire engineering world. It has freed the magnificent lake front of Chicago from the belt of slimy filth which formerly reached out as far as the crib which forms the intake for the water supply, and it has restored the shore of Lake Michigan to a satisfactory condition. It has reversed the current of the Chicago river, and directed its water toward the Mississippi, so that what was once little more than an open sewer is now a river worthy of the name. Still more important, it has provided a sanitary outlet for the sewage of the great city and given it such a drainage as health and comfort demand.

Mr. Johnston shows conclusively that the legal requirement of 20,000 cubic feet per minute of dilution flow for the sewage of 100,000 people is none too great an allowance, especially in warm weather, and for a city of the population of Chicago this corresponds to about 350,000 cubic feet per minute flow through the river. The Chicago Sanitary District, the legal body which has been authorized to control the sanitary regulation of the Chicago region, is therefore fully sustained in its requirements, so far as sanitary conditions are concerned.

The opposing interests are found in the commercial requirements for the river as a navigable stream. Before the opening of the channel, the river was practically without current, the motion being almost inappreciable, so far as navigation is concerned. The handling of vessels was therefore a comparatively simple matter, and consequently inexpensive.

With the opening of the canal, however, all this has been changed. To those who have become familiar with the currents in the great tidal rivers on the coast, the objections to the current which the canal discharge has produced in the river seem rather unnecessary, but these objections are most natural, coming from those who have been accustomed to the former stagnant waters of the muddy stream.

Being a navigable stream, the river comes under national control, and all regardless of the requirements of sanitation, the government has limited the current to a maximum of 1¼ miles an hour. Experience has shown, however, that this limit is exceeded even before the required discharge of the Sanitary District is reached.

There appear to be but two remedies: either the flow must be restricted or the cross section of the river increased. When it is considered that both banks of the stream are lined with valuable properties, while under its bed are numerous tunnels for tramways, with arch crowns close to the bed-surface, it will be seen that the cost for damages renders enlargement of the prism almost prohibitory. Preliminary estimates make the cost for such an improvement almost equal to that originally required for the building of the canal itself, and preliminary estimates are usually far exceeded when litigation and obstruction have finished their costly work.

There is, however, another remedy, which has not been attempted, namely, the possible modification of the requirements of the national government. Nearly all great engineering works are the result of a number of compromises, and when the health of a great city and the prosperity of its port are closely bound together in such a manner, it is surely reasonable for concessions to be made on both sides.

In this connection a most excellent suggestion has been made by the veteran engineer, General Wm. Sooy Smith, which will bear repeating here. He says:

"As a contribution to the discussion of

the Chicago river, its conditions, and the necessity of the enlargement of the channel, necessary for the flow through it of the quantity of water prescribed by the drainage act, without producing a rate of current that would be detrimental to navigation, I would suggest the necessity of a capacious harbor as a roadstead and place of anchorage for vessels which might require such accommodation, instead of having them crowded into the channel of the river. This suggestion grows out of the advisability of minimizing the difficulty of towing and handling vessels in a rapid current; but the far more important consideration is the fact that the great and increasing commerce of the port of Chicago absolutely requires a capacious harbor for its accommodation. The out-shore breakwater already constructed by the United States government affords nearly all the protection required for such a harbor, and it can be completed at a comparatively small cost, only requiring to be deepened by dredging, which is now being done.

"The river furnishes a certain amount of accommodation as a harbor, and it is valuable as a means of reaching the docks of the city. With the addition of the enlargement proposed and in progress, Chicago will have a harbor commensurate with its needs and importance as the greatest of our lake ports.

"Much of the shipping is now going to South Chicago, and much more will go there and thus relieve to some extent the Chicago river of the duty it is now called upon to perform. The deepening of the harbor will complete the improvement which the Federal government is wisely carrying out on a liberal scale."

The Modernization of an Electric Station.

The question of depreciation of plant is one which has often been discussed, and the propriety of scrapping machinery while it is yet in condition for many more years of service has been alternately advocated and condemned. The best answer to such questions is found in the examination of actual instances in which such a policy has been adopted, and an excellent example is found in the modernization of the plant at Atlanta, Georgia.

The plant which has just been replaced, according to an account in the *American Electrician,* was entirely new and up to date in 1890, and was typical of the practice of that time, consisting of a large number of small generating units, increased in number as the business of the plant demanded. These additions resulted in the multiplication of machinery types and the conglomeration of small generating sets to such an extent as to overcrowd the station and render operation so difficult and expensive, that, in the spring of 1900, when the oldest portion of the plant was but 10 years old, it was decided to reconstruct the entire station, as well as the system, modernizing the complete plant.

"The general scheme of the present plant, which is almost completed, is as follows: At the main station three-phase alternating currents are generated at 2500 volts and 60 cycles, and a primary distribution system for lighting and power purposes is supplied directly from the alternator bus-bars; this distribution system is restricted to that portion of the city outside of the fire district. The service within the fire district is all direct current, supplied by underground mains from a sub-station located at almost the precise center of the district. This sub-station receives three-phase alternating currents at the voltage and frequency above named, through underground feeders, and transforms these currents, by means of three-phase, two-phase transformers and rotary converters, into direct current, which is delivered to an ordinary three-wire 230-volt Edison distribution system. All arc lamps, motors, and incandescent lamps within the fire district are supplied from these mains, while the lighting and power service without the district is all by alternating current. The municipal arc lamps outside the fire district are series arcs supplied through constant-current transformers in the main generating station. The main station also contains direct-current railway generators of the usual type, which supply the street-railway system of the city. These generators are reinforced by a rotary converter, and an additional rotary is to be put in which will also be used for the railway service."

Instead of a number of small engines the plant is equipped with large compound engines, of the McIntosh-Seymour, Rice &

Sargent, Greene, and Harris-Corliss makes, most of these being direct-connected to the generators, although a few of the old dynamos have been retained and are driven by belt.

The sub-station, located about 1¼ miles from the main station, and close to the distribution centre, contains the transformers, rotary converters, and accumulators, thus enabling the distribution service to be effected with much economy and advantage. The changes in voltage necessitated the rewiring of every customer's premises, and connection to the new mains, all these changes having been accomplished without making any interruption to the service.

Apart from the interest which naturally attaches to such an important piece of technical and administrative work, this operation forms a most striking example of the great changes which have taken place in central station practice in ten years' time, and emphasises the soundness of the position that it pays to scrap old machinery as soon as it has outgrown its usefulness.

Here was a plant, comparatively new, with all its distribution and business organisation, turned over to a new and enterprising corporation. The first act of the new management was to throw the entire plant overboard just as rapidly as it could be replaced by new and improved appliances, even though this involved the placing of new mains and the construction of new buildings. That the commercial advantages of the change must in the long run outweigh the expense is conceded, but it takes courage to act in such a radical manner, the courage that goes with conviction and with knowledge.

Probably the progress of improvement has been more rapid in electrical practice during the past ten years than it has been in some older branches of engineering, but the principle is the same.

Street railway plants have been replaced by cable traction, and this again by electric traction, all within the past fifteen years, and in each case the entire plant has been scrapped, to make way for its successor. The lesson is clear, and in modern works management the question of providing for the rapid depreciation due to the progress of the art can no longer be ignored or disputed.

Standard Water Analyses.

THERE is no more encouraging sign of the progress in the care of the public health than the interest which is taken in the study of methods of prevention of disease, and among these none is more important than the maintenance of a pure water supply.

The report of the committee on standard methods of water analysis, at the recent meeting of the American Public Health Association, published in the *Engineering Record,* gives an excellent idea of the thoroughness with which this problem is being attacked. The report must be examined as a whole for detailed description of the methods which are recommended, but a general view of the subject may be given here.

A specimen of drinking water, when examined according to the reported method, is studied as to its physical characteristics, including turbidity, color, and odor. This is followed by the microscopical examination, in which the bacteria which may be present are studied as to their classification and character, after which the quantitative bacteriological examination is made. As this latter is a most important portion of the work, it is especially desirable that all the data secured at the large number of laboratories both in America and in Europe shall be placed on a comparable basis. For this reason the committee has taken great care to obtain the best available evidence of the methods of procedure in many important laboratories and formulated standard rules for the bacteriological examination of water.

These rules include directions as to the collection of samples of the water to be examined, including cleaning, preparation for transportation, proper temperature, and permissible interval of time between collecting and plating. Standard methods for making sterilized culture media are also given, followed by rules for plating, incubation, and counting.

The committee reports that the responses to correspondence indicate no very great differences in practice in these important details, so that the work of unifying methods is rather one of system than of selection. Nearly all the differences in methods are those naturally due to the differences in the conditions under which the studies of various investigators are conducted, and it is by no means the intention of the committee to discourage individual methods, but merely to show how such studies may be made to include the data necessary for general and international comparisons.

The work of the committee is by no means considered to be completed, and the present report is merly one of progress, but is sufficiently complete to enable systematic work to be commenced and doubtless to provide material for further suggestions.

The whole question of unifying scientific studies is one which demands careful consideration in all lines of work. Properly carried out, standard methods of investigation must result in the accumulation of an enomous amount of valuable data, where otherwise there would have been but a mass of heterogenous results. At the same time it must remembered that the slavish adoption of codes and rules may act as a serious obstacle to independent investigation unless the student has sufficient judgment to know when to see and how to examine phenomena on his own account. One of the principal disadvantages of standard methods lies in the difficulty which it offers to the discrimination between the work of a thorough investigator and that of a routine subordinate. When a method is reduced to a mere set of rules, which may be followed by the veriest tyro, all reports have a similarity in form which may often obscure the real difference in value and reliability. Method and system are all very well, but these can never supersede independent study and investigation, and each should supplement the other.

The Measurement of Flowing Water.

One of the things which might well be classed with the "way of a bird in the air" or the "way of a fish in the sea," as past finding out, is the way of a stream in its bed, and from the time of Frontinus to the present men have studied the behaviour of flowing water, and attempted to devise methods for measuring its velocity and volume.

Among the appliances which have been used for determining the velocity of water is that known as the Pitot tube. This simple device consists of a tube of which the ower end is bent at right angles to the vertical. When such a tube is placed in a stream with the open end pointing towards the advancing body of water, the velocity of the water will cause it to rise in the tube and the extent of the rise in the tube is used as a measure of the velocity of the flow.

In a paper discussing the formula for use with the Pitot tube, read before the Louisiana Engineering Society by Mr. W. M. White, and published in the Journal of the Association of Engineering Societies, some very interesting and valuable data are collected, which may go far toward extending the use of this device, or rather of extricating it from the disuse into which it has fallen.

Much of the paper of Mr. White is taken up with a controversy with Mr. William Kent as to the value of the coefficient to be used in connection with the tube. Into this controversy it is not our intention to enter, but we do desire to emphasize the importance of the trials made by the writer, as showing the practical value of the device when intelligently used in competent hands.

The experiments by Mr. White include a number in which the study was made of the impingement of jets of water upon flat plates, and upon nozzles of different forms, but the most interesting tests were those in which the tubes were moved through still water at a known velocity, and thus accurately calibrated. One of the important results of these tests was the fact that there was no difference in the readings for tubes with nozzles of different shapes, so long as the nozzle is a surface of revolution with its axis exactly in the line of motion. In all cases the law for the conversion of velocity into static head was shown to be the same as that for the conversion of head into velocity.

An ingenious device for rendering the Pitot tube available for velocities too low to give visible readings by the ordinary scale, is the oil gauge, in which oil is substituted for air in the Pitot tube gauge. By this substitution the difference between the two water levels increases until the difference between the weights of the column of oil and the column of water, due to their different specific gravities, is equal to the pressure at the point. Thus, with an oil of the specific gravity of 0.9, the scale reading is multiplied ten times.

Comparisons between the Pitot tube and the current meter have shown that when the tube is properly calibrated, and carefully used, it is quite as accurate as the current meter, and very much more convenient. Besides giving a visible reading at once, it permits a study of variation in the velocity, permitting the different parts of the cross section of a stream to be explored and the influence of obstructions, surfaces, etc., upon the velocities to be investigated. It is to such uses of the instrument that we may, perhaps, look for the solution of some problems relating to the flow of water, which are at present unsolved, such as those relating to the internal work of the water, in which, rather than in frictional channel-resistance, much of the resistance to flow may reside.

It is to such investigations as those of Mr. White, rather than to theoretical discussions based on insufficient data, that we must look for increased knowledge of this most important and difficult branch of hydraulic engineering, and it is to be hoped that these studies are but the forerunners of many others.

The Modern Office Building.

SEVERAL years ago a party of French travellers were taken to the top of one of the tall buildings in New York City, and shown the view of the lower portion of the metropolis. Upon being asked what most impressed him, one of the visitors remarked that he was especially struck by the jets of exhaust steam which he perceived issuing from nearly every roof around him.

"I thought these were office buildings, but they look more like factories," was the comment. The remark was more nearly correct than was understood at the time, for the modern office building in most instances contains as much of a power plant as many factories, and is often far more carefully planned.

In a paper recently presented before the American Society of Civil Engineers by Mr. Charles G. Darrach, and published in the *Proceedings* of the society, the general features of the mechanical installation of a modern office building are discussed at length.

"The mechanical installation in the modern office building presents to the engineer a field for the best utilization of his energies. The office building of to-day contains all the conveniences and necessities of a great city, the microcosm of which it is. In addition to the engineering features of a city, a denser population must be provided for; and the varied interests and conveniences of each tenant must be thoughtfully studied in order to make the little city a success.

"In the general arrangement of the apparatus, there must be considered economy of space, comfort, safety and economy in operation; convenience in distribution, adaptability to modification, ease in repairs, and beauty of design; and the machinery must be constructed at the least cost, to be operated at the minimum expense."

As far as possible, an office building should be an individual, depending upon no other, public or private; and it is possible to be independent of everything except primary supplies and sewage disposal. Mr. Darrach divides the necessities into the following heads:

Heating and ventilation,
Lighting,
Water Supplies and Sewage disposal,
Policing and fire protection,
Transportation,
Communication with the outside world.

"The source of power almost invariably adopted is steam, as it can be utilised for heating the building after doing its work in the engines. The boiler power required to heat under the most severe conditions is, except in some very high buildings, generally sufficient to operate the machinery. Practice indicates the installation of from 140 to 200 horse power for maximum use per 1,000,000 cubic feet of contents, with one additional boiler unit in reserve." Data are given showing the conditions under which heating must be effected in various parts of the United States, with examples drawn from actual practice.

Next to heating and ventilation, comes the question of lighting, and the general practice is to use incandescent electric lighting, the 16-candle power lamp being the standard. Experience shows that the maximum amount of current used will vary from 50 to 60 per cent. of the total installation, including the engine and boiler lighting, one indicated horse power being allowed for 10 to 12 incandescent lamps.

Water supply is an important item in the equipment of the miniature city, and besides the feed for the boilers, water is required for the wash basins, etc., for drinking, for sanitation, and for use in refrigerating apparatus. The source is generally the city water supply, but the water is either pumped directly into the pipe system, or into reservoir tanks in the attic. Fire protection is necessary for the contents of rooms, even though the building itself is fireproof. Fire hose and nozzles must be provided, with electric signals to the engine room; and portable chemical fire-extinguishers conveniently placed on each floor.

The very important subject of transportation, that is, elevator service, is most thoroughly discussed by Mr. Darrach, with a very complete analysis of the actual working conditions of several important buildings in Philadelphia and New York. Tabulated data and formulas are given for computing the area served by elevators in buildings of various heights are given, together with comments upon various details of the apparatus. The preference is undoubtedly given to electric elevators, when a separate source of current from the lighting system can be employed.

"However perfect the installation, without proper management, it will fail; success depends upon the operating engineer, who should be an educated engineer and a cool executive with ready wit, willing hand, and untiring energy, as well as a competent mechanic—the most important machine in the installation."

The Coal Fields of China.

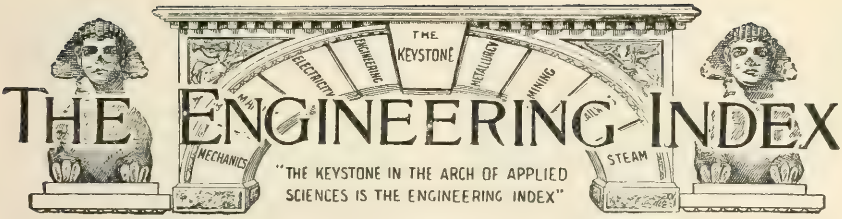
THE great interest which has been given to the coal question in all parts of the world, has included China, and although nearer fields will doubtless attract more attention, the paper of Mr. N. F. Drake, presented before the American Institute of Mining Engineers may be noted briefly, as calling attention to the great coal riches there awaiting development.

Mr. Drake treats of the northeastern portion of the Chinese empire describing those which he himself has mapped and investigated. These include the Kai-Ping field, near Tongshan, the Wang-Ping field, west of Peking, the Ling-Shan field, near Paoting, and the field around Tse-Chou.

The general location of these fields are indicated by an excellent map, and geological sections show the location and depth of seams. The coal is bituminous and produces good coke, but varies in the different localities. The Wang-Ping field has long been worked, the use of the coal having been mentioned by Marco Polo in the thirteenth century, but until recently it has been difficult to get information about them.

Details of the various fields, and the extent to which they are available, are given in Mr. Drake's paper, but the principal fact to which attention may now be called is the enormous quantity which is available for future use. Those who are fearful as to the possible exhaustion of the world's supply of coal should take courage from Mr. Drake's statement. Says he.

"Suppose these fields to represent equal areas, we have a general average of 23 feet for the whole region. This belt has a linear extent of about 500 miles. If we take a width of only 50 miles, and suppose that, because of denuded areas, only one-half is coal-bearing, we still have 12,500 square miles of coal. This would give us about 350,000,000,000 tons, which would be enough to supply the world at its present rate of consumption, for many centuries. It may be doubted whether the coal fields above noted represent average conditions along the whole of this extensive belt: but the figures I have given may be accepted with confidence, so far as they go. In giving estimates I have endeavored to underestimate the probable quantities. If we consider all the workable beds, instead of one big bed, our estimated totals would have to be very much increased. In the Kai-Ping coal field, the big bed contains only about one-third of the workable coal; in the Wang-Ping basin it contains a much smaller proportion; but in the other fields it covers most of the workable coal. A further study of the coal fields is likely to show them to be more extensive than we have supposed hitherto."



The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title, (2) The name of its author,
(3) A descriptive abstract, (4) Its length in words,
(5) When published, (6) Where published.
We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Bridge Renewal.

Sunday Work on Railway Bridges. Discusses the methods of renewal with as little interruption of traffic as possible. 3600 w. Engr, Lond—Sept. 13, 1901. No. 43348 A.

Caisson Disease.

The Occurrence and Treatment of Caisson Disease in Engineering Work. Facts concerning the limits within which work under compressed air can be carried on, taken from the discussion of a paper by Benjamin Hall Blythe. Also editorial.

6600 w. Eng News—Sept. 5, 1901. No. 43171.

Concrete Arch.

An Articulated Concrete Arch Bridge. An illustrated account of a proposed structure in Spain, which departs widely from the customary practice of that country. 1500 w. Engr, Lond—Sept. 6, 1901. No. 43223 A.

East River Bridge.

Erection of the New East River Bridge Approaches. Illustrated detailed description of the structures between New York and Brooklyn and their erection. Two independent travelers are in use. 3800 w. Eng Rec—Sept. 21, 1901. No. 43367.

The Temporary Footways of the New East River Bridge. Brief description, with illustrations. 900 w. Sci Am—Sept. 14, 1901. No. 43199.

Foot-Bridge.

The New Foot-Bridge Over the Seine at Paris. Illustrates and describes a structure built for the exposition, but made permanent. 700 w. Engng—Sept. 6, 1901. No. 43224 A.

Highway Bridges.

Highway Bridge Design and Construction. Extracts from a set of general specifications for highway bridges, prepared by C. C. Schneider, with editorial comments on their important features. 3500 w. Eng Rec—Sept. 7, 1901. No. 43120.

Lift Bridges.

Rolling Lift Bridges. Waldon Fawcett. Remarks on the rolling lift bridges constructed during the past few years, and types previously used. Ill. 1400 w. Sci Am—Sept. 28, 1901. No. 43379.

Loads.

Rolling Loads on Railway Bridges. Discusses the best method of determining the effect of rolling loads, considering especially the methods used in England. 2300 w. Engr, Lond—Aug. 23, 1901. No. 43-039 A.

Mexico.

American Bridges in Mexico. Illustrates and describes points of interest in bridges manufactured in American shops for the Vera Cruz & Pacific R. R. 1200 w. Eng Rec—Aug. 31, 1901. No. 43088.

Plate-Girder.

The Collapse of a Long Plate Girder Bridge. An account of an accident while testing a bridge in France, in July, 1897. 1500 w. Eng Rec—Sept. 21, 1901. No. 43371.

Red River Bridge.

The Red River Bridge at Alexandria, La. Illustrated detailed description of a bridge being built for the Shreveport and Red River Ry. The bridge proper is 941 ft. in length, and the trestle approach is 4,800 ft. It has three fixed spans and a draw-span. 800 w. R. R. Gaz—Sept. 20, 1901. No. 43335.

Suspension.

A Curious Suspension Bridge. H. G. Tyrrell. Illustrations and brief description of a suspension foot-bridge recently completed at Easton, Pa. It is built with three towers, thus forming two spans. On account of the great difference in the elevation of the two ends the floor has a 7 per cent. grade, and four runs of stairs. 250 w. Sci Am Sup—Sept. 28, 1901. No. 43382.

Swing Bridge.

Four-Track Two-Truss Swing Bridge; Chicago & Western Indiana R. R. Illustrated description of a novel design, with discussion of its advantages. 2000 w. Eng News—Sept. 12, 1901. No. 43191.

Temporary Bridge.

Temporary Bridge Over the Connecticut River at Hartford, Conn. H. G. Tyrrell. Describes briefly the old bridge and the proposed new bridge; but especially the temporary bridge made necessary by the burning of the old structure. Ill. 1300 w. Ry & Engng Rev—Aug. 31, 1901. No. 43083.

Viaduct.

The Gokteik Bridge. J. C. Turk, in the *World's Work*. Extracts of interest from an article by the engineer in charge of the work of erection of the Gokteik Viaduct, Burma. Ill. 2500 w. R R Gaz—Sept. 6, 1901. No. 43156.

CONSTRUCTION.

Building Details.

Dwelling Houses; Their Sanitary Construction and Arrangement. W. H. Corfield. Concerning the proper ventilation of houses. 1800 w. Dom Engng—Sept. 15, 1901. No. 43315 C.

Test of a Vault-Light Slab. Illustrated report of a test to destruction of a concrete-steel slab fitted with lenses for use over sidewalk vaults. 900 w. Eng Rec—Sept. 7, 1901. No. 43127.

The Chicago National Bank Building. Illustrates and describes the construction of a 90½ x 181½-foot four-story steel and brick structure. 2400 w. Eng Rec—Aug. 31, 1901. No. 43090.

The Power House of the Bristol Railway. Illustrates and describes a fire-proof steel building 140 ft. long, 50 ft. wide, and 116 ft. high, constructed in America and erected in England by employees sent for the purpose. 1600 w. Eng Rec—Sept. 21, 1901. No. 43369.

Foundations.

The Foundation for the New York Stock

Exchange. C. F. Maurice. Illustrated description showing the latest designs and improvements in caisson foundation building. 2100 w. R R Gaz—Sept. 27, 1901. No. 43395.

The Foundation for the New York Stock Exchange. Illustrates and describes the method of sinking the foundation walls and piers, which show many novel features. 1400 w. Ir Age—Sept. 26, 1901. No. 43358.

Framework.

Kinematic Theory of Framed Arches (Kinematische Theorie des Fachwerkbogens). H. Ramisch. An application of kinematic analysis to forms which are statically indeterminate. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 6, 1901. No. 43425 B.

The Determination of the Axes of the Internal Members of a Plane Framework (Bestimmung der Achsenlagen der Füllungsglieder ebener Fachwerke). A. Umlauf. An examination of the true axial position of the verticals and diagonals of a truss under deflection. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 30, 1901. No. 43422 B.

Mechanical Plant.

Mechanical Installation in the Modern Office Building. Charles G. Darrach. Presents for discussion the various necessities of the modern office building and some general rules for practice which experience indicates. 5500 w. Pro Am Soc of Civ Engrs—Aug., 1901. No. 42974 E.

Pan-American.

The Ethnology Building at the Pan-American Exposition. Illustrated explanation of the heavy timber framing, including the timber trusses of a dome of nearly 90 ft. diameter. 1800 w. Eng Rec —Sept. 7, 1901. No. 43125.

Simplon Tunnel.

The Construction of the Simplon Tunnel (Der Bau des Simplon-Tunnels). C. J. Wagner. An analysis and discussion of the work upon the Simplon tunnel from January 1, 1900, to January 1, 1901. Two articles. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 23, 30, 1901. No. 43420 each B.

The Work on the Simplon Tunnel (Simplon Tunnel). Report, showing the progress of the work during the quarter ending June 30, 1901. 1200 w. Schweizerische Bauzeitung—Aug. 24, 1901. No. 43439 B.

Steel-Concrete.

Steel-Concrete Construction. An informal discussion at the annual convention. Ill. 12500 w. Pro Am Soc of Civ Engrs—June 26, 1901. No. 42982 E.

Subway.

The New York Rapid Transit Subway. Illustrated description of details of tunnels and methods of construction of the underground railway now being built. 1700 w. Elec Rev, N. Y.—Sept. 21, 1901. No. 43355.

Tunnels.

The Proposed Tunnel Between Scotland and Ireland. James Barton. Abstract of a paper read before the Glasgow Congress. Discusses briefly the selection of a site, the line, the water question, ventilation and cost. 1300 w. Engng—Sept. 6, 1901. No. 43228 A.

CANALS, RIVERS AND HARBORS.

Bilbao.

Works for Improving the Bilbao River and Making an Outer Harbor, also the Application of Large Caissons as a Breakwater Foundation. Senor Don Evaristo de Churruca. Abstract of a paper read before the Glasgow Congress. Outlines the work and reports the satisfactory results. 1100 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43241 A.

Canals.

The Dortmund and Ems Canal. Herr Hermann. Abstract of paper read before the Glasgow Congress. Describes the route and dimensions of the canal, its ports, cost, and working. 2700 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43239 A.

Two Interesting Canal Relics. Brief illustrated descriptions of the inclined plane of the Shropshire canal, and the aqueduct of the Shrewsbury canal. 700 w. Engr, Lond—Aug. 30, 1901. No. 43141 A.

Chicago.

I. The Chicago River. Thomas T. Johnston. A discussion of the sanitary and navigation interests. II. Discussion. Isham Randolph. III. Notes on "The Chicago River." Ernest L. Cooley. The last two papers disagree with statements made in the first. 13300 w. Jour W Soc of Engrs—Aug., 1901. No. 43052 D.

Clyde.

The River Clyde and Harbor of Glasgow. W. M. Alston. Extract from paper read before the Glasgow Congress. Describes the "docks," and their equipment, giving information concerning the traffic, revenue, etc. 1600 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43240 A.

Coos Bay.

Description of Coos Bay, Oregon, and the Improvement of Its Entrance by the Government. Discussion of paper by William W. Harts. 10000 w. Pro Am Soc of Civ Engrs—Aug., 1901. No. 42977 E.

Dams.

Stability of Small Dams. John H. Gregory. Gives a series of formulas used by the writer, which give by the solution of one equation the width of the base. Explanations. 2000 w. Eng Rec—Sept. 21, 1901. No. 43368.

Dredges.

Two Sea-Going Suction Dredges. Illustrated general description of two powerful machines to be used in the Southwest pass and Cumberland Sound, South Carolina. 900 w. Marine Rev—Aug. 29, 1901. No. 42997.

Mississippi.

The Improvement of the Lower Mississippi River. J. A. Ockerson. Extracts from a paper read before the Glasgow Congress. An interesting summary of work in progress. Describes the conditions, the revetment and contraction works, levers, etc. 3000 w. Eng News—Sept. 19, 1901. No. 43327.

Nile.

Irrigation in the Nile Valley, and Its Future. W. Willcocks. Read before the Glasgow Congress. Describes the main features of basin irrigation and considers the lessons to be drawn from the wisdom of the ancient Egyptians. Ill. 6200 w. Engng—Sept. 6, 1901. No. 43229 A.

The Regularization of the Nile. Editorial discussion of the river as represented in Sir William Garstin's recent report as to irrigation projects on the Upper Nile. 2000 w. Engng—Sept. 6, 1901. No. 43226 A.

Obstructions.

Obstructions to Commerce and How to Remove Them. Lewis M. Haupt. Discusses the physical obstacles that man must overcome, such as sand bars, peninsulas, isthmuses, etc.; traces the work in this field that has been accomplished in the United States, the cost, etc. 6800 w. Jour Fr Inst—Sept., 1901. No. 43056 D.

MATERIALS.

Building Stones.

Sedimentary Building Stones of Colorado. Arthur Lakes. Illustrated article describing the valuable formations of limestone, sandstone, etc., and the uses to which their colors and qualities are suited. 3000 w. Mines & Min—Sept., 1901. No. 43095 C.

Cement.

Report of the Board of Engineers, U. S. A., on the Properties and Testing of Hydraulic Cement. Almost full report of the investigations of the Board of Engineers on the manipulating and testing of hydraulic cements used in the public works, and the conclusions. 12300 w. Eng News—Sept. 12, 1901. No. 43197.

Fireproofing.

The Fireproofing of Wood. A. H. Eldredge. Methods of fireproofing are described and results given of tests on wood that has been treated. 1700 w. Mach, N. Y.—Sept., 1901. No. 43000.

Paving Brick.

Commercial Brick Testing. Outlines methods of brick testing, giving illustrations. 1300 w. Brick—Sept., 1901. No. 43148.

Tests for Paving Brick. A concise history of the rattler tests. 4800 w. Brick—Sept., 1901. No. 43147.

Tests.

Bridge Metal and Bridge Tests. A synopsis of the report presented by Max Edler von Leber at the International R. R. Cong., at Paris, with the conclusions and comments. 1700 w. R R Gaz—Sept. 13, 1901. No. 43207.

MEASUREMENT.

Metric System.

The Metric Convention and the International Bureau of Weights and Measures (La Convention du Mètre et le Bureau International des Poids et Mesures). C. E. Guillaume. A historical account of the practical development of the metric standards and of the work of the International Bureau at Breteuil. Serial, Part I. 5000 w. Bull Soc d'Encour—Aug. 31, 1901. No. 43430 G.

See Mechanical Engineering, Machine Works and Foundries.

Surveying.

The Solution of Certain Geodetic Problems in Connection with Canal Construction (Ueber Lösungen Geodätischer Aufgaben bei Verfassung der Detailprojecte von Wasserstrassen). J. Urbanski. An analysis of some of the surveying problems connected with the projects for the Danube-Moldau Canal. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 30, 1901. No. 43421 B.

Water Measurement.

Instructions for Installing Weirs, Measuring Flumes and Water Registers. Clarence T. Johnston. Illustrated directions for weirs, measuring flumes, and registers, describing in detail the Gurley register, the Friez, the Leitz and the Standard. 3500 w. Eng News—Aug. 29, 1901. No. 43012.

MUNICIPAL.

Garbage Plant.

The Garbage Reduction Plant at Boston, Mass. Describes a plant which combined the Arnold reduction process with a method of ammonia recovery involving the use of by-product coke ovens. Ill.

3000 w. Eng Rec—Sept. 14, 1901. No. 43268.

Pavements.

Brick Pavements and the Engineer. Taylor Gleaves. Concerning vitrified brick pavements, discussing the early mistakes, and suggesting specifications. 2500 w. Brick—Sept., 1901. No. 43149.

Some Lessons from the Macadam Pavements of Albion, N. Y. Halbert Powers Gillette. Describes a Medina sandstone macadam pavement, the method of construction, cost of repairs, and details of interest. 3000 w. Eng News—Sept. 19, 1901. No. 43331.

The Cost and Durability of Brick Pavements in Ithaca. Extracts from a paper by C. L. Crandall, presented to the League of Am. Municipalities, describing minutely the construction and durability of many brick pavements. 1700 w. Eng Rec—Sept. 7, 1901. No. 43124.

The Design of Economic Streets and Pavements. Halbert Powers Gillette. Discusses economic pavement design, considering the foundation, sub-soil and wearing coat, and criticizes existing designs. 3000 w. Eng News—Sept. 5, 1901. No. 43170.

The Development of Bituminous Pavements. Fred. J. Warren. Read before the League of Am. Municipalities. Reviews briefly the history of this form of pavement, with comments on the various practices. 2000 w. Am Gas Lgt Jour—Sept. 16, 1901. No. 43266.

Sanitation.

Municipal Sanitation. William Weaver. Abstract of a paper before the Glasgow Congress. Discusses sewerage and drainage, water supply, highways and refuse. 1400 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43254 A.

Sewage Disposal.

Sewage Disposal by Intermittent Filtration at the Montgomery Co. Infirmary, Near Dayton, O. Benjamin H. Flynn. Illustrated description of the disposal works, and account of cost. 1000 w. Eng News—Sept. 12, 1901. No. 43196.

The Management of Septic Tanks and Bacterial Contact Beds. Gilbert J. Fowler. From a paper read before the Royal Inst. of Public Health, and published in the London *Contract Journal*. Gives results of experience at Manchester, Eng., discussing the destruction of sludge, the production of an easily vitrified effluent, reduction of suspended matter, etc. etc. 2800 w. Eng News—Sept. 19, 1901. No. 43330.

Sewers.

Difficult Sewer Reconstruction. Harrison Souder. Illustrates difficult work in Philadelphia, where great care had to be exercised to prevent caving, and the operations were rendered more difficult by the presence of many gas, water, and drainage pipes. 500 w. Eng Rec—Aug. 31, 1901. No. 43089.

Flow in the Sewers of the North Metropolitan Sewerage System of Massachussetts. Continued discussion of paper by Theodore Horton. 800 w. Pro Am Soc of Civ Engrs—Aug., 1901. No. 42980 E.

Street Sweeper.

See Electrical Engineering, Power Applications.

Vienna.

Drainage and Improvement Works at Vienna (Travaux d'Assainissement et d'Embellissement de la Ville de Vienne). R. Philippe. A full account of the improvements made in the past ten years, including the river and sewer regulation, and the metropolitan railway. 3000 w. 1 plate. Génie Civil—Sept. 7, 1901. No. 43407 D.

WATER SUPPLY.

Accidents.

The Accidents at the East Side Water-Works Intake Tunnel, Cleveland, O. Gives a full account of the accidents of Aug. 14 and Aug. 20, resulting in the loss of life. Ill. 2300 w. Eng News—Aug. 29, 1901. No. 43014.

Chicago.

The Water-Works System of Chicago. Brief historical review with illustrations. 3800 w. Fire & Water—Sept. 14, 1901. No. 43262.

The Water-Works System of Chicago. J. H. Spengler. A review of the development and growth, especially the extensive additions and improvements during the past five years. Ill. 23300 w. Jour W. Soc of Engrs—Aug., 1901. No. 43051 D.

Consumption.

The Consumption of Water in Municipal Supplies and the Restriction of Waste. An informal discussion of the annual convention, July 27, 1901. 10900 w. Pro Am Soc of Civ Engrs—Aug., 1901. No. 42-984 E.

Croton Dam.

The Croton Dam for the Water Supply of New York City. Illustrations and brief description of this work, and discussion of some changes that may be considered desirable. 1200 w. Sci Am—Sept. 21, 1901. No. 43325.

Decolorization.

The Decolorization of Water. An informal discussion at the annual convention, June 26, 1901. Ill. 15500 w. Pro Am Soc of Civ Engrs—Aug., 1901. No. 42983 E

Faucets.

The Design of Faucets of Limited Flow (Dispositifs pour la Limitations du Debit dans les Bornes-fontaines et Robinets). P. A. Berges. Giving illustrations of forms of faucets requiring the continual action of the user to maintain the flow, thus preventing the waste of water by negligence. 1500 w. Génie Civil—Aug. 17, 1901. No. 43402 D.

Filtration.

The Lawrence, Mass., City Filter: A History of Its Installation and Maintenance. Discussion of paper by Morris Knowles and Charles Gilman Hyde. Ill. 15000 w. Pro Am Soc of Civ Engrs—Aug., 1901. No. 42978 E.

Ground Water.

The Definition of a Running Underground Stream. Review of a decision by the South Dakota Supreme Court, hinging on a precise definition of a running underground stream. 1000 w. Eng Rec—Sept. 7, 1901. No. 43122.

The Ground Water Supply of Chemnitz, Germany. Description of a supply drawn from wells, of which the yield is artificially increased by diverting part of the water of a neighboring stream over the surface of the land near the wells. 1200 w. Eng Rec—Sept. 7, 1901. No. 43123.

Merthyr Tydvil.

Merthyr Tydvil New Water-Works. An interesting description of this nearly completed work which has been in progress many years and been attended with great difficulties. 2500 w. Engr, Lond—Sept. 6, 1901. No. 43221 A.

Purification.

Purification of Water for House Purposes. W. H. Matlack. Considers ways that water is contaminated, and the means of purification. 3300 w. Dom Engng—Sept. 15, 1901. No. 43314 C.

Reservoirs.

Repairing a Leaking Cofferdam; and Pile-Driving Methods at the Leech Lake Storage Reservoir, Minn. W. C. Weeks. An illustrated description of interesting reconstruction work, describing the methods used to stop leaks, the construction, and details of experiences in connection with the work. 2800 w. Eng News—Sept. 19, 1901. No. 43328.

The New Water Works Reservoir at Trenton, N. J. Charles Arthur Hague. Illustrated description of a reservoir of 110,000,000-gals. capacity, and interesting features of its construction. 2500 w. Fire & Water—Aug. 31, 1901. No. 42993.

Villages.

Some Notes on Village Water Supply. Arthur C. Auden. Considers means of utilizing existing sources, such as wells, springs, etc., and arranging for the distribution. 1700 w. Engr, Lond—Aug. 23, 1901. No. 43040 A.

Wells.

Driven Wells for Fire Purposes. John C. Spencer. Read at Indianapolis convention of the International Assn. of Chief Engrs. Explains the details of construction of a well that has proved very successful for this purpose. Ill. 1800 w. Fire & Water—Aug. 31, 1901. No. 42994.

Well Sinking.

Well Sinking Extraordinary. Describes the methods used in sinking a well in India, to provide water for the use of the palace of H. H. the Maharaja of Bikaner. 1800 w. Col Guard—Aug. 23, 1901. No. 43045 A.

MISCELLANY.

Computing.

Short and Easy Methods for Computing Probable Errors. E. A. Fuertes. Explains the method giving an account of its origin. 2000 w. Pro Am Soc of Civ Engrs—Aug., 1901. No. 42975 E.

Ethics.

Ethics of the Engineering Profession. Victor C. Alderson. A discussion of the principles underlying this profession and the effect on the mind and character. 3000 w. Jour W. Soc of Engrs—Aug., 1901. No. 43054 D.

Practice.

Civil Engineering Practice: Shall It Be Regulated by Law? Informal discussion at the annual convention, June 26, 1901. 5800 w. Pro Am Soc of Civ Engrs—Aug., 1901. No. 42981 E.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

A Graphic Proof of the Betts Test. E. Raymond-Barker. Shows the adaptability of Mr. Betts' test for locating faults in submarine cables, to graphic illustration, giving diagram and explanatory notes. 800 w. Elec Rev, Lond—Sept. 13, 1901. No. 43337 A.

Coherers.

See Electrical Engineering, Electro-Physics.

Exchange.

Tunbridge Wells Municipal Telephone

Exchange. Brief description of a recently opened small system possessing features differing from usual practice. Ill. 1400 w. Elect'n, Lond—Sept. 13, 1901. No. 43338 A.

Field Lines.

Field Telegraph Lines. Sabin Gibbs, Jr. Illustrates and describes systems of field connections, and reports concerning the working of such lines, and the transportation of materials. 3000 w. Elec Rev, N. Y.—Sept. 21, 1901. No. 43356.

Franchises.

The Franchises of Telephone and Telegraph Companies, Legislative, Municipal and Congressional. G. C. Hamilton. Discusses questions relating to the granting of franchises, legislation, etc. 3000 w. Telephony—Sept., 1901. No. 43372.

Selective Signaling.

Telephone Magnetoes for Delivering Pulsating Current for Selective Signaling. N. H. Holland. Describing an improved form of magnets for "individual call" telephone circuits. 1200 w. Elect Wld & Engr—Aug. 31, 1901. No. 43011.

Space Telegraphy.

Experiments with Wireless Telegraphy Between Brussels-Mechlin-Antwerp (Versuche mit Drahtloser Telegraphie zwischen Brüssel-Mecheln-Antwerpen). E. Guarini. A brief description of the apparatus and résumé of the results; the distances ranged from 21 to 41 kilometers. 1800 w. Elektrotech Zeitschr—Aug. 8, 1901. No. 43447 B.

How to Construct an Efficient Wireless Telegraph Apparatus at a Small Cost. A. Frederick Collins. Description dealing only with the practical side of the subject. Ill. 2000 w. Sci Am—Sept. 14, 1901. No. 43201.

Submarine.

Submarine Telegraphy. J. Wright. Reviews the early history of cable lines, the difficulties met; their working, etc. Ill. 4800 w. Ind & East Engr—Aug., 1901. No. 43175 B.

Telephony.

Efficiency of Telephone Generators. W. S. Henry. Gives a method of comparing the capacities of telephone generators. 1400 w. Am Elect'n—Sept., 1901. No. 43069.

Public Co-operation in Perfecting Telephone Service. Joseph B. Baker. Discusses the importance of educating the public in the use of the telephone, thus increasing its efficiency, and greatly lessening delays. 2500 w. Elec Wld & Engr—Sept. 7, 1901. No. 43161.

Telephony from a Scientific Standpoint. Harry S. Coyle. Some remarks on the ignorance concerning the essential principles of the science, and its progress as an art. 1800 w. Telephony—Sept., 1901. No. 43373.

DISTRIBUTION.

Combined Energy.

Distribution of Combined Electrical Energy. Alton D. Adams. Outlines the methods of distributing electrical energy gathered from several sources of generation, describing those used at Manchester, N. H., and Hartford, Conn. 1500 w. Sci Am—Sept. 7, 1901. No. 43106.

Converters.

Motor Generators vs. Rotary Converters. An account of an exhaustive test of two different types of motor-generators of considerable capacity, as to their efficiency, power-factor, rise of temperature, regulation and individual losses. Also editorial. 2800 w. Elec Wld & Engr—Sept. 21, 1901. No. 43364.

High Potential.

The Control of High Potential Systems of Large Power. E. W. Rice, Jr. Read before the Am. Inst. of Elec. Engrs., at Buffalo, Aug. 23, 1901. Outlines the principal features of the switching device employed by the Metropolitan Traction Co. of N. Y., and discusses the principles that should govern the control of current. Ill. 4000 w. Elec Rev, N. Y.—Sept. 7, 1901. No. 43117.

Hydraulic Analogies.

Some Notes on Electric Light and Power Distribution. Daniel W. Mead. Shows the analogies to hydraulic transmission and gives tabulated information of value, and wiring diagram. 1800 w. Munic Engng—Sept., 1901. No. 43049 C.

Insulation.

India-Rubber Strip for Insulation Purposes. H. L. Terry. Notes the increased use of the "spread" strip in preference to "cut," and the reasons. Outlines the processes to which the raw material is subjected, and discusses longevity and other matters of interest. 1600 w. Elect'n, Lond—Aug. 23, 1901. No. 43027 A.

On the Electric Strength of Insulating Materials. C. Baur. Notes on some investigations for determining the electrical breaking strengths. 1300 w. Elect'n, Lond—Sept. 6, 1901. No. 43212 A.

Low-Tension Feeding.

The Relative Advantages of Three-, Two-, and Single-Phase Systems for Feeding Low-Tension Networks. Michael B. Field. Abstract of a paper read at Glasgow Congress. Considers the generating and transforming machinery, and the different systems. 1400 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43257 A.

Regulations.

Government Regulations Affecting Electric Power Distribution. A copy of the memorandum of the regulations committee sent to the electrical adviser of the British Board of Trade, with editorial comment. 2500 w. Engng—Aug. 30, 1901. No. 43144 A.

Underground Mains.

Highfield-Cater System of Underground Mains. An illustrated description of a novel system now undergoing a practical trial. Some of the points claimed are small space, no drawing boxes, cheapness and rapidity, thorough protection, etc. 2000 w. Elec Rev, Lond—Aug. 23, 1901. No. 43025 A.

Wiring.

Overhead Wiring Distribution System for Pressures below 1,000 Volts (Installations material für Oberirdische Starkstrom-Vertheillungsnetze mit Spannungen unter 1,000 Volt). H. Bönninghofen. An illustrated description of the practice of the Allgemeine Elektricitäts-Gesellschaft, of Berlin. 2000 w. Elektrotech Zeitschr—Aug. 8, 1901. No. 43446 B.

ELECTRO-CHEMISTRY.

Accumulators.

Edison's Alkaline Storage Batteries. E. J. Wade. From a forthcoming book. Discusses the specifications and information given in paper by Dr. A. E. Kennelly. 2000 w. Elect'n, Lond—Aug. 23, 1901. No. 43028 A.

Electric Furnace.

An Electric-Resistance Magnesia Crucible-Furnace for Laboratory-Use. Prof. Henry M. Howe. Illustrates and describes a furnace designed for the metallurgical laboratory of the School of Mines of Columbia University, N. Y. 1000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 43301 D.

The Use of the Electric Arc as a Means of Fusion (Die Verwendung des Elektrischen Lichtbogens für Schmelzzwecke). Dr. Bermbach. A discussion of the thermal reactions in the use of the electric furnace for fusing alumina, carbide, glass, etc. 3500 w. Elektrotech Zeitschr—Aug. 1, 1901. No. 43443 B.

Electrolysis.

Secondary Reactions in Electrolysis. Joseph W. Richards. States some of the laws of primary electrolysis and secondary reactions, giving a classification of the latter, and discussing examples under each heading by way of illustration and suggestion. 7000 w. Jour Fr Inst—Sept., 1901. No. 43057 D.

History.

The Beginning of Electrolytic Chemistry. Discusses the early work in this field. 800 w. Elec-Chem & Met—Aug., 1901. No. 43021 A.

ELECTRO-PHYSICS.

Coherers.

Some Experiments on Filings Coherers. W. H. Eccles. Describes investigations made to confirm or correct and to amplify the very meagre information available on the effects of steady e. m. f.'s on filings coherers. 3800 w. Elect'n, Lond—Aug. 23, 1901. Serial. 1st part. No. 43029 A.

Discharge-Currents.

The Discharge-Current From a Surface of Large Curvature. John E. Almy. A study of the discharge from a platinum wire of very small size to a concentric circular cylinder. Ill. 1200 w. Am Jour of Science—Sept., 1901. No. 42985 D.

Iron.

Magnetic Investigations Upon Modern Varieties of Iron (Magnetische Untersuchungen an Neueren Eisensorten). E. Gumlich & E. Schmidt. A report to the Reichsanstalt of the conductivity, coercitive force, permeability, and general magnetic properties of a variety of irons and steels. 10,000 w. Elektrotech Zeitschr—Aug. 29, 1901. No. 43452 B.

GENERATING STATIONS.

Armatures.

The Winding of Continuous-Current Slotted Armatures. Translation of an article by Alexander Rothert in the *Electrotechnische Zeitschrift.* An illustrated discussion of points relating to the manufacture of continuous-current machines. 3800 w. Elec Engr, Lond—Aug. 23, 1901. No. 43023 A.

Alternators.

The Artificial Loading of Alternators (Künstliche Belastung von Wechselstrommaschinen). R. Goldschmidt. A discussion of the heating of alternators under various conditions of loading. 2000 w. Elektrotech Zeitschr—Aug. 22, 1901. No. 43456 B.

Birmingham, Ala.

A Modern Southern Central Station. J. R. Williams. Illustrates and describes the new power house equipment of the Consolidated Light & Power Co., at Birmingham, Ala. 1200 w. Am Elect'n—Sept., 1901. No. 43064.

Dynamos.

Dynamo Ills and Remedies. From the *National Engineer.* A discussion of the cause and remedy of troubles. Ill. 4000 w. Can Elec News—Sept., 1901. No. 43311.

Large Continuous-Current Generators (Grosse Generatoren für Gleichstrom). H. M. Hobart. A comparison of the practice in Europe and America, together with criticisms of the design of Rothert. 2500

w. Elektrotech Zeitschr—Aug. 15, 1901. No. 43449 B.

The Effect of Short Circuited Field Coils Upon the Operation of an Electric Generator. William Baxter, Jr. Explains the effect upon two-pole and multipolar machines and the reasons. Ill. 2500 w. Marine Engng—Sept., 1901. No. 43074 C.

Efficiency.

The Maximum Efficiency of Continuous Current Generators (Der Maximale Wirkungsgrad von Gleichstrommaschinen). Dr. L. Finzi. A demonstration that the maximum efficiency is attained when the losses due to the unloaded machine and the losses due to the load are equal. 800 w. Elektrotech Zeitschr—Aug. 8, 1901. No. 43445 B.

Farnworth, Eng.

Farnworth Electricity Works and Tramways. Illustrated detailed description of plant for power and lighting. 3700 w. Elec Engr, Lond—Aug. 23, 1901. No. 43022 A.

German Practice.

Some Details of German Electrical Generating Station Practice. E. Kilburn Scott. Illustrated article commenting on points of interest observed during a recent visit by the English Inst. of Elec. Engrs. 1700 w. Elec Wld & Engr—Aug. 31, 1901. No. 43009.

Hydro-Electric Plant.

A Combined Railway and Lighting System in Switzerland. Enrico Bignami Illustrated description of the Alstaetten-Berneck electric railway and the electric lighting of Alstaetten, in the northeast portion of Switzerland. 1600 w. Elec Rev, N. Y.—Sept. 14, 1901. No. 43264.

The Electric Plant at the Poses Dam (Installations Electriques du Barrage de Poses). E. Bret. An illustrated description of the plant at Poses on the Seine, near Amfreville, where about 13,000 h. p. is developed at mean water. Especial measures are provided for variable flow. 2500 w. 1 plate. Génie Civil—Aug. 24, 1901. No. 43403 D.

Water Powers of the Springfield, Mass., United Electric Light Company. Alton D. Adams. Illustrated description of the plants established by this company for utilizing the power of nearby water falls. 3500 w. Elec Wld & Engr—Sept. 28, 1901. No. 43392.

Joint Works.

The Kensington and Notting Hill Companies' Joint Electricity Supply Works. Illustrated detailed description of the works. The alternating-current system is used, and three-phase generators. 4000 w. Elect'n, Lond—Sept. 6, 1901. Serial. 1st part. No. 43210 A.

Parallel Running.

Parallel Operation of Alternators. A. S. M'Allister. Discusses the operation on the output side of the machines. 1500 w. Am Elect'n—Sept., 1901. No. 43067.

Polyphase.

Polyphase Electric Working. A. C. Eborall. Howard Lecture. Deals with the machinery employed in polyphase working, discussing the leading features. The present lecture considers the design and construction of three-phase generators. Ill. 3600 w. Jour Soc of Arts—Sept. 13, 1901. Serial. 1st part. No. 43336 A.

Prague.

The Electrical Power Station of the City of Prague. Notes on this plant, taken from the *Zeitschrift,* of the society of German Engineers. Ill. 2500 w. Eng Rec—Aug. 31, 1901. No. 43087.

Reconstruction.

Reconstruction of a Water and Electric Lighting Station at Warren, O. Drawings and photographs showing the improvements made, with account of the works, and facts of interest concerning them. 1600 w. Eng News—Sept. 5, 1901. No. 43168.

Regulation.

Compensation of Alternators for Circuits of Varying Power Factors. Sydney Woodfield. Gives a description of the automatic regulating apparatus of the General Electric Company, etc. 1100 w. Elec Rev, Lond—Aug. 30, 1901. No. 43132 A.

Single-Phase.

The Prospects of Single-Phase Supply. W. E. Warrilow. Discusses the prospect of single-phase supply for tramways, and reviews the past history, concluding that the method is not on the decline. 2000 w. Elec Engr, Lond—Aug. 23, 1901. No. 43024 A.

Switchboards.

The Design of Switch Gear. W. E. Warrilow. The present number is principally devoted to high pressure gears. 1700 w. Elec Rev, Lond—Sept. 6, 1901. Serial. 1st part. No. 43214 A.

Tyne.

Electric Power Supply on the Tyne. The present article gives an illustrated description of the Neptune Bank Station, with the history of the undertaking. 1800 w. Engr, Lond—Sept. 13, 1901. Serial. 1st part. No. 43351 A.

LIGHTING.

Isolated Plant.

The Electric Light and Power Installation at the Lancashire County Asylum, Prestwich, England Illustrated detailed description. 4000 w. Elec Engr, Lond—Aug. 30, 1901. No. 43133 A.

Lamp Sockets.

The Testing of Gauges for Edison Lamp Sockets (Bestimmungen betreffend die Prüfung von Lehren für die Füsse und Fassungen von Edison Glühlampen). A discussion of the standard threads for lamp sockets recommended by the *Verband Deutscher Elektrotechniken* and adopted by the Reichsanstalt. 3500 w. Elektrotech Zeitschr—Aug. 15, 1901. No. 43448 B.

Luminous Fountains.

A Brief History of Luminous Fountain Development. Luther Stieringer. An elaborately illustrated article giving the history as far as known of illuminated fountains. 4800 w. Elec Wld & Engr—Sept. 14, 1901. No. 43187.

Nernst.

Investigations on the Nernst Lamp (Untersuchungen über die Nernst lampe). Dr. W. Wedding. Giving details of photometric tests of various models, with numerous diagrams. 3500 w. Elektrotech Zeitschr—Aug. 1, 1901. No. 43442 B.

Vapor Lamp.

The Cooper-Hewitt Vapor Lamps. An account of the ten patents recently issued, with illustrated description of the lamp and its operation. Also editorial. 9200 w. Elec Wld & Engr—Sept. 28, 1901. No. 43393.

MEASUREMENT.

Galvanometer.

Shunt for Galvanometers (Nebenschlusskasten für Galvanometer). W. Volkmann. Description of a special form of shunt for varying the sensitiveness of a galvanometer. 1000 w. Elektrotech Zeitschr—Aug. 15, 1901. No. 43450 B.

Instruments.

Kelvin's Electric Measuring Instruments. Prof. Magnus Maclean. Read before the Elec. Section of the International Engng. Cong. at Glasgow. (Abstract.) Brief illustrated descriptions of various classes of instruments patented by Lord Kelvin. 2500 w. Elec Rev, Lond—Sept. 6, 1901. No. 43215 A.

Meter.

Graduated Tariff Meter for Consumers (Verbrauchs-Stufenmesser und Selbstthätige Staffel-Tarifanzeiger). Dr. Kallman. Describing an automatic recording meter for varying rates of charge for current to the consumer. 5000 w. Elektrotech Zeitschr—Aug. 22, 1901. No. 43455 B.

Polyphase.

Polyphase Measuring Appliances (Ueber Drehfeldmessgeräthe). F. Schrottke. Illustrated description of the apparatus made by Siemens & Halske of Berlin. 10,000 w. Elektrotech Zeitschr—Aug. 15, 1901. No. 43451 B.

Testing.

The Rating and Testing of Electrical Machinery. Gisbert Kapp. Gives the standards provisionally adopted by the German Assn. of Elec. Engrs., discussing the subject. 5400 w. Inst of Mech Engrs —Glasgow Congress, 1901. No. 43280 D.

POWER APPLICATIONS.

California.

Electric Power Plants in the Mining Districts of Northern California. G. P. Grimsley. Briefly reviews some of the plants in use and proposed. 1100 w. Eng & Min Jour—Aug. 31, 1901. Serial. 1st part. No. 43004.

Cranes.

Electric Equipment of Cranes. Will Rung. Deals with the various types of motor applicable to crane work, having reference also to the nature of the supply current. Also the controlling gear. Ill. 2000 w. Elec Rev, Lond—Sept. 6, 1901. Serial. 1st part. No. 43217 A.

Electric Printing.

Spence's Electric Motors for Hoe Four-Roll Printing Machine. Illustrated description of the machine, its electric appliances and operation. 2400 w. Engng—Aug. 23, 1901. No. 43038 A.

Elevators.

Electrically Controlled Hydraulic Elevators. William Baxter, Jr. An illustrated description of an elevator so arranged as to not require an attendant operated by electricity obtained from direct current incandescent lighting circuits. 1300 w. Am Mach—Sept. 12, 1901. Serial. 1st part. No. 43186.

Induction Motor.

Asynchronous Induction Motor Without Phase Variation Between Current and Pressure (Asynchroner Induktions motor bzw. Generator ohne Phasenverschiebung zwischen Strom und Spannung). A. Heyland. The rotary field is produced from the secondary armature, and a closed commutator is used. 2000 w. Elektrotech Zeitschr—Aug. 8, 1901. No. 43444 B.

Measurement and Computation of the Losses of Unloaded Induction Motors (Messung und Berechnung der Leerlaufverluste von Drehstrommotoren). Dr. G. Benischke. Describing the application of the stroboscopic disk for the determination of slip at various loads. 2500 w. Elektrotech Zeitschr—Aug. 29, 1901. No. 43453 B.

The Induction Motor for Electric Railways. The present article gives an abstract of a recent paper by Albert H. Armstrong entitled "Notes on Modern Electric Railway Practice." 3000 w. Elec Wld & Engr—Sept. 14, 1901. Serial. 1st part. No. 43189.

The Induction Motor. Harris C. Trow. An explanation of the induction motor and its action. 3400 w. Engr, U. S. A.—Sept. 1, 1901. No. 43077

Mill Power.

Electric Power Equipment for Dominion Cotton Mills Company. Illustrated description of the installation of electric power in mills at Montreal. 4000 w. Can Engr—Sept., 1901. No. 43081.

Polyphase.

Report on the Wüst Polyphase Motor (Bericht über Untersuchungen an einem Drehstrom-Motor mit Abstufbarer Tourenzahl; Patent Wüst). Drs. Weber and Denzler. Description of a polyphase motor with speeds ranging from 700 to 1,500 revolutions per minute. 2500 w. Schweizerische Bauzeitung—Aug. 31, 1901. No. 43440 B.

The Computation of the Short-Circuit Current in Polyphase Motors (Die Berechnung des Kurzschlusstromes von Drehstrommotoren). A. Siewert. A mathematical investigation, showing the relation between the short circuit current and the magnetization. 5000 w. Elektrotech Zeitschr—Aug. 1, 1901. No. 43441 B.

Pumping.

Electrically-Operated Pumps. Frank C. Perkins. Illustrates and describes various types of centrifugal pumps operated electrically, and states the purposes for which they are especially suited. 1600 w. Sci Am Sup—Sept. 14, 1901. No. 43202.

The "Bull" Electric Motor. Illustrated description of an English motor for driving a pump. 500 w. Engng—Sept. 13, 1901. No. 43344 A.

Street Sweeper.

An Electric Street Sweeper. Waldon Fawcett. Illustrates and describes a novel sweeper used in Cleveland, O. 800 w. Munic Engng—Sept., 1901. No. 43050 C.

TRANSMISSION.

Canada.

The Chambly-Montreal Power Transmission. Illustrated description of an important medium-distance high-tension two-phase transmission line in Canada. 2400 w. Elec Rev, N. Y.—Sept. 14, 1901. No. 43265.

Line.

Some Details of High-Tension Pole Line Construction. C. O. Pole. An illustrated description of the pole line construction adopted by the Standard Electric Co., of California, confined principally to the mechanical construction. 4000 w. Jour of Elec—Aug., 1901. No. 43352 C.

The Bay Counties Transmission Line. C. E. Dutcher. Illustrated detailed description of a double pole line of best material and workmanship. 2300 w. Jour of Elec—Aug., 1901. No. 43353 C.

Long Distance.

Elements of Design Particularly Pertaining to Long-Distance Transmission. F. A. C. Perrine. Presented at the annual convention of Am. Inst. of Elec Engrs., at Buffalo. Considers important phenomena in connection with long-distance problems. 2500 w. Elec Rev, N. Y.—Aug. 31, 1901. No. 43001.

MISCELLANY.

Germany.

Visit of the Institution of Electrical Engineers to Germany. E. Kilburn Scott. An interesting account of the visit of this British society, the works inspected, etc. Ill. 3800 w. St Ry Jour—Sept. 7, 1901. No. 43166 D.

Radiography.

Origin and Uses of the X-Rays. Dr. W. R. Fox. Digest of a lecture delivered before the Insurance Institute of Victoria, N. S. W., with descriptions of demonstrations given to illustrate the principles. 2800 w. Aust Min Stand—July 25, 1901. No. 43145 B.

Standardization.

The Standardization of Electrical Apparatus. J. T. Broderick. The subject is discussed from the standpoint of the manufacturer mainly, showing its manifest advantages. 2600 w. The Engineering Magazine—Oct., 1901. No. 43481 B.

GAS WORKS ENGINEERING

Acetylene.

The Position of Calcium Carbide and Acetylene. Reviews an article by Dr. Münsterberg, recently published in the *Zeitschrift für Beleuchtungswesen.* 2000 w. Engr, Lond—Sept. 13, 1901. No. 43350 A.

Address.

Inaugural Address of the President of the Gas Section of the International Engineering Congress in Glasgow. George Livesey. 3000 w. Jour Gas Lgt—Sept. 3, 1901. No. 43172 A.

Analysis.

Estimation of Phosphorus and Suphur in Acetylene and Other Combustible Gases. Describes a combustion method, with the use of oxygen. 2500 w. Jour Gas Lgt—Aug. 27, 1901. No. 43115 A.

Automatic Apparatus.

Automatic Lighting and Extinguishing Apparatus. M. A. Rothenbach. Read before the Gas Section of the Glasgow Congress. Explains clock work apparatus made in Switzerland and states its advantages. Discussion. 1700 w. Gas Wld—Sept. 7, 1901. No. 43209 A.

Carbonizing.

The Construction of Inclined Retort Carbonizing Plants. Walter Ralph Herring. Read before the Gas Section of the Glasgow Congress. Considers the differences between British and Continental practice, the types, distinctive features, charging and discharging, coke conveyors, regenerative chambers, etc. Also discussion. 10000 w. Gas Wld—Sept. 14, 1901. No. 43339 A.

Coke-Oven Gas.

The Production of Illuminating Gas From Coke-Ovens. F. Schniewind. Read before the Glasgow Congress. Describes the progress made in the United States and Canada in recovering illuminating gas from bye-product coke-ovens, discussing its bearing on the smoke problems. Discussion. Ill. 17000 w. Jour Gas Lgt—Sept. 17, 1901. No. 43398 A.

Consumers.

The Relation of the Consumers to the Gas Manager. S. B. Langlands. Read at the meeting of the Irish Assn. of Gas Mgrs. Considers the best means of strengthening the relationship. General discussion follows. 4000 w. Gas Wld—Aug. 14, 1901. No. 43030 A.

Electrolysis.

Destruction of Gas-Pipes by Means of Electricity. Dr. W. Leybold. Read before the Gas Section of the Glasgow Congress. An explanation of the action of the electric current, with description of the conditions found. General discussion. 6500 w. Jour Gas Lgt—Sept. 10, 1901. No. 43320 A.

Enrichment.

The Influence of Enrichment on the Heating Power of Coal Gas. M. Verdier. Read at annual meeting of the Société Technique. An account of tests with interesting conclusions concerning the heating and illuminating value of coal gas 2200 w. Jour Gas Lgt—Aug. 27. 1901 No. 43114 A.

Gas Brackets.

See Mechanical Engineering, Machine Works and Foundries.

Gasholder.

The Principles of Construction of a Proposed Modern Gasholder for Amsterdam. J. Van Rossum du Chattel. Read before the Gas Section of the Glasgow Congress. An illustrated description of an annular tank above the ground, the largest of the kind ever constructed. States the conditions, difficulties, and methods. Discussion. 4400 w. Gas Wld—Sept. 14, 1901. No. 43340 A.

Gas Transmission.

A Long Gas Transmission System. Illustrated description of a series of pipe lines owned and operated by the Philadelphia Co., of Pittsburg, and used for the transmission of natural gas from the gas producing district they control to various points of consumption. 700 w. Compressed Air—Sept., 1901. No. 43285.

Purification.

Application of the Unit System of Gas Manufacture to Its Purification. Charles Carpenter. Read before the Gas Section of the Glasgow Congress. Describes an experiment tried and the results obtained. General discussion follows. Ill. 5500 w. Jour Gas Lgt—Sept. 10, 1901. No. 43321 A.

Station Lighting.

Evolution: Old Lamps and New for Railway Station Lighting. Showing the advantages of the latest scientific methods of gas lighting. 1800 w. Jour Gas Lgt—Aug. 27, 1901. No. 43112 A.

Water Gas.

Experience with Carburetted Water Gas Sets. A. C. Beck. Read before the Pacific Coast Gas Assn. An illustrated account of improvements introduced at Oakland, Cal., to overcome defects in manufacture and aid in the efficiency of the machines. Also discussion. 4500 w. Am Gas Lgt Jour—Sept. 9, 1901. No. 43151.

The Utilization of Water Gas in the Destructive Distillation of Coal. Vivian B. Lewes. Read before the Gas Section of the International Engng. Cong. at Glasgow. Describes experiments made at the Crystal Palace Dist. Gas. Works, showing the great economy obtained. Discussion. 8300 w. Gas Wld—Sept. 7, 1901. No. 43208 A.

Welsbach.

The Welsbach "Patent" of 1893. Information of importance regarding the validity of this patent, with editorial comment. 4000 w. Jour Gas Lgt—Aug. 27, 1901. No. 43113 A.

INDUSTRIAL ECONOMICS

Cost-Keeping.

The Proper Distribution of Establishment Charges. A. Hamilton Church. The present article deals with the classification and dissection of shop charges, showing the method and its advantages. 4500 w. The Engineering Magazine—Oct., 1901. No. 43482 B.

Labor.

A Plan to Utilize Unemployed Labor. James A. Stewart. Outlines a plan for building homes by co-operation and giving employment to the unemployed in their own business. 1800 w. Jour Assn of Engng Socs—Aug., 1901. No. 43288 C.

Labor Questions.

Some Aspects of the Labor Question and Shop Ethics. Egbert P. Watson. A discussion of some of the points that cause disturbances in labor. 4800 w. Ir Age—Sept. 19, 1901. No. 43312.

Premium System.

A Premium System of Remunerating Labor. James Rowan. Describes a premium system tried in an effort to solve the piecework problem. 2400 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43279 D.

The Premium System of Remunerating Labor. James Rowan. Abstract of a paper read at the Glasgow Congress. Gives a description of a premium system used in marine-engine manufacture. 2400 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43259 A.

Profit-Sharing.

Mr. W. H. Lever on Profit-Sharing. Discusses the objections set forth by Mr. Lever in published articles. 2500 w. Jour Gas Lgt—Aug. 27, 1901. No. 43111 A.

Steel Strike.

The Outcome of the Steel Strike. Gives the strikers' view of the causes of their failure, including President Shaffer's statement. 2500 w. Ir Trd Rev—Sept. 26, 1901. No. 43386.

Trusts.

European Trusts. Reviews the report compiled by J. W. Jenks, the United States Industrial Commission's trust expert, concerning investigations extending over two years and embracing visits to the leading European industrial centers. 2000 w. Col Guard—Sept. 13, 1901. No. 43-342 A.

Wages.

Wages in the German Coal Industry. A statement of the present condition of the industry, the reductions made in wages, and the question of Polish labor. 1700 w. Col Guard—Sept. 13, 1901. No. 43341 A.

MARINE AND NAVAL ENGINEERING

Battleships.

Contract Trial of the United States Sea-Going Battleship "Illinois." James M. Pickrell. Illustrated detailed description of the vessel and its equipment with report of trial. 7200 w. Jour Am Soc of Nav Engrs—Aug., 1901. No. 43302 H.

Trial of Great Battleships. An account of the trial of the "Retvizan," built for the Russian government. The builder's tests made in the Atlantic, off Delaware capes. 1200 w. Naut Gaz—Sept. 19, 1901. No. 43357.

Boilers.

See Mechanical Engineering, Steam Engineering.

Boiler Trials.

The Boiler Trials of H. M. S. "Hyacinth" and "Minerva." Official report and editorial discussion. 7300 w. Engng—Aug. 30, 1901. No. 43142 A.

Compass.

A Study of the Compass (Studio sulla Bussola). G. Pes. A theoretical and mathematical investigation of the magnetic deviation of the compass. 7000 w. Rivista Marittima—Aug.-Sept., 1901. No. 43462 H.

Corrosion.

A Simple Method for Preventing the Corrosion of Tail Shafts. James M. Thornton. Describes the author's method of protection and preservation, which experience has shown will make them last for years without breaking. Also discussion and plate. 2700 w. Trans of N. E. Coast Inst. of Engrs. & Shipbuilders—July, 1901. No. 42992 E.

Cruisers.

Some Notable Scottish Products. Illustration, with description of two cruisers of the County class, with their engines and machinery. 2600 w. Marine Rev—Sept. 19, 1901. No. 43323.

Displacement.

The Displacement and Dimensions of Ships. J. A. Normand. Read before the Glasgow Congress. Give approximate rules for the determination of the displacement and dimensions of a ship in accordance with a given programme of requirements. 2000 w. Engng—Sept. 6, 1901. No. 43233 A.

Explosions.

Racing Steamboats and Exploding Boilers. Editorial maintaining that steamboat racing is not dangerous, and giving some explanatory notes on the modern type of boiler. 1400 w. Eng News—Sept. 12, 1901. No. 43194.

Fog Signals.

Foster's Fog Signals. Illustrated description of this apparatus, which is in the form of a single automatically revolving megaphone, which turns to each of the eight points of the compass in turn, and gives a signal. 1000 w. Sci Am—Sept. 28, 1901. No. 43380.

Grounding.

The Grounding of the German Battleship "Kaiser Friederich III." Translated from *Marine Rundschau.* An account of the circumstances attending the grounding of this vessel on the 2nd of April, 1901, causing considerable damage, and the lessons taught by the accident. Ill. 5300 w. Jour Am Soc of Nav Engrs—Aug., 1901. No. 43304 H.

Hulls.

Hull Design. George Crouse Cook. Considers the efficiency as determined by the form of the under-water body. 1400 w. Marine Rev—Sept. 26, 1901. No. 43385.

Jet Propulsion.

A Study of Hydraulic Propulsion (Etude de la Propulsion Hydraulique). Marchand Bey. A mathematical analysis of the hydraulic principles involved in jet propulsion, with examples of practical application. 3000 w. Revue de Mécanique—Aug. 31, 1901. No. 43428 + F.

Launch.

Launch of the Mallory Steamer "Denver." Illustrates and describes a launch of more than ordinary interest because of the great dimensions and weight of the vessel, and the narrow stream into which she was launched. 3500 w. Marine Engng—Sept., 1901. No. 43072 C.

Liner.

The New Atlantic Liner "Kronprinz Wilhelm." Brief illustrated description of this large, high-speed vessel. 700 w. Sci Am—Sept. 14, 1901. No. 43198.

The New German Atlantic Liner "Kronprinz Wilhelm." Describes this new high-speed liner and its equipment, reporting the trial. 1800 w. Engng—Sept. 13, 1901. No. 43347 A.

Mexico.

Steam Navigation on the Rivers of Tabasco. Abstract of a contract to establish regular steam navigation on the rivers of the State of Tabasco. 500 w. U. S. Cons Repts, No. 1,139—Sept. 14, 1901. No. 43178 D.

Navies.

Engineering in the Royal Navy. The first of a series of articles, considering the true position of machinery and those employed in working and tending it on board men-of-war. 1800 w. Engr, Lond—Aug. 30, 1901. No. 43140 A.

The World's Navies. Information from the government annual showing progress made in vessel construction and armament. 3000 w. Naut Gaz—Sept. 5, 1901. No. 43118.

Oil Motors.

See Mechanical Engineering. Special Motors.

Shallow Water.

Shallow Water Navigation. William H. Crawford, Jr. Remarks on the designs of boats for the shallow rivers of the United States and how well they accomplish the work required of them. Ill. 1800 w. Marine Engng—Sept., 1901. No. 43073 C.

Shipbuilding.

Plant of the New York Ship Building Company. Waldon Fawcett. An account of this new yard at Camden, N. J., and its equipment. 2500 w. Am Mfr—Sept. 5, 1901. No. 43109.

The Clydebank Shipbuilding and Engineering Works. The present article describes the general arrangements of the works, the building berths and launching ground, the ship platers and fitters' department, mechanics' shop, woodworking department, etc. Ill. 3800 w. Engng—Aug. 23, 1901. Serial. 1st part. No. 43033 A.

Shipping.

The Waste of Shipping. Editorial comments based on Lloyd's Return, just issued. 1200 w. Engng—Aug. 23, 1901. No. 43036 A.

Ship Ventilation.

Mr. F. W. Jennings' Reply to the Discussion of His Paper on "The Ventilation and Heating of Ships." 2300 w. Trans of N-E Coast Inst of Engrs & Shipbuilders—May, 1901. No. 42988 E

Shipyards.

Some Remarks on the Commercial Organization of Shipyards. Walter Scott.

Considers the subject under the headings of correspondence, estimating, buying, cost-keeping, bookkeeping, commercial staff, and development. Also general discussion. 7700 w. Trans of N-E Coast Inst of Engrs & Shipbuilders—May, 1901. No. 42987 E.

Steamship Line.

A Great Vessel Organization. From *Fairplay*. History of the City line purchased for the Indian trade. 2400 w. Marine Rev—Sept. 12, 1901. No. 43177.

Torpedo Boats.

Contract Trials of the Torpedo Boats Shubrick and Thornton. H. Webster. Illustrated detailed descriptions of the boats and their equipments, with account of trials. 5000 w. Jour Am Soc of Nav Engrs—Aug., 1901. No. 43303 H.

Largest Torpedo Boats of Any Navy. Brief illustrated description of the torpedo boat destroyers "Truxtun," "Whipple," and "Worden" of the U. S. government. 600 w. Marine Rev—Sept. 26, 1901. No. 43384.

U. S. Torpedo Boats, "Bagley," "Barney," and "Biddle." Charles P. Wetherbee. Illustrated detailed descriptions of these vessels, with report of trials. 2800 w. Jour Am Soc of Nav Engrs—Aug., 1901. No. 43305 H.

Torpedoes.

Discharging Torpedoes by Electricity. Describes the process of launching a torpedo, with diagrams. 1500 w. Elec Rev, Lond—Aug. 30, 1901. No. 43130 A.

Turrets.

Shipbuilder Cramp's Views on Battleship Turrets. Letters to the chief constructor of the United States navy. 4400 w. Naut Gaz—Sept. 26, 1901. No. 43389.

Warships.

The Protection of Warships in the Nineteenth Century (La Protegione delle Navi da Guerra nel Secolo xix). A. Ruggieri. A general study of armored protection of vessels at the close of the century. 8000 w. Rivista Marittima—Aug.-Sept., 1901. No. 43463 H.

Water-Tight Compartments.

Water-tight Subdivision of Ships. Theodore Lucas. Discusses the importance of this subject at the present time, and where the bulkheads ought to be placed, their construction, etc. 1500 w. Naut Gaz—Sept. 5, 1901. No. 43119.

Yachts.

Twin Screw Pleasure Yacht "Prinzessen Victoria Luise." Illustrated description of a new type of pleasure steamer built for long cruises. 600 w. Marine Engng—Sept., 1901. No. 43071 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Axle.

A New Driving Axle for Automobiles. Sectional view, with description. 800 w. Sci Am—Sept. 21, 1901. No. 43324.

Cylinder Cooling.

Cooling of the Cylinders of High Speed Internal Combustion Engines and Its Effect Upon the Power Developed. Prof. Hele-Shaw. Read before the Mech. Engrs. Sec. of the Glasgow Con. Discusses the overheating of the cylinders and its prevention. Ill. 1700 w. Autocar—Sept. 7, 1901. No. 43219 A.

Endurance Run.

Impressions of the New York-Buffalo Endurance Contest. Albert L. Clough. A report of lessons learned from this recent trial concerning the weak points of the machines, and other matters of interest. Conclusions, remarks and editorial. 7400 w. Horseless Age—Sept. 18, 1901. No. 43317.

The New York-Buffalo Endurance Run. An account of the entries, the start, the first and second stages of the run, the hill climbing contest, and much matter of interest. Ill. 10800 w. Horseless Age—Sept. 11, 1901. No. 43180.

The New York-Buffalo Endurance Run. Detailed report of the third, fourth, fifth and sixth stages, with comments. 9500 w. Horseless Age—Sept. 18, 1901. No. 43318.

Gasoline Vehicle.

The Rocket-Schneider Gasoline Vehicle. From *La France Automobile*. Illustrated particulars concerning this machine. 1800 w. Horseless Age—Sept. 4, 1901. No. 43105.

Glasgow Trials.

Glasgow Exhibition Motor Trials. Illustrates and describes many of the competing vehicles. Also editorial. 14000 w. Auto Jour—Sept., 1901. No. 43399 A.

The Glasgow Autocar Trials. Particulars of the trials and competing vehicles, with illustrations. 2800 w. Autocar—Aug. 31, 1901. No. 43129 A.

The Motor Vehicle Durability Trials. Brief account of these trials, made with the object of testing the durability of the vehicles, with report of the results. 1800 w. Engr, Lond—Sept. 13, 1901. No. 43349 A.

Motor Cycle.

A New Motor Cycle. Illustrated description of an English invention, in which the motor is embraced by the back wheel. 1200 w. Sci Am—Sept. 28, 1901. No. 43381.

Mowing Machine.

Gasoline Motor Mowing Machine (Faucheuse Automobile à Pétrole). G. Coupan. Illustrated description of the Deering automobile mowing machine as exhibited at Plessis, near Châteauroux, France. 1200 w. 1 plate. Génie Civil—Aug. 31, 1901. No. 43404 D.

Newport Races.

The Newport Automobile Races. An illustrated account of the races at Newport, R. I. 600 w. Sci Am—Sept. 14, 1901. No. 43200.

Steam Carriage.

The Clarkson Steam Carriage and Kerosene Burner. Illustrated description of a design by an English engineer showing considerable deviation from American practice. 2000 w. Horseless Age—Sept. 4, 1901. No. 43104.

Touring Vehicle.

The Larchmont Motor Company's Touring Vehicle for the Endurance Run. Illustrated detailed description. 1600 w. Horseless Age—Sept. 11, 1901. No. 43179.

Variable Speed.

The de Moutais Speed-Changing Device. Half-tone and line engravings, with description of a device adapted particularly to automobile purposes. 700 w. Am Mach —Sept. 26, 1901. No. 43374.

HYDRAULICS.

Flow.

Comparison of Formulas for Flow of Water in Clean Cast-Iron Pipes. Letters from John C. Trautwine, Jr., E. Sherman Gould and Frank S. Bailey, discussing the difficulty of determining a constant coefficient for the flow of water in pipes. Aug. 15. 2700 w. Eng News—Sept. 12, 1901. No. 43195.

Hydraulic Plant.

Hydraulic Plant. An illustrated article, giving particulars of a plant from the laying of the foundation to the testing of the engines, calling attention to important points. 1000 w. Prac Engr—Aug. 23, 1901. No. 43019 A.

Pitot Tube.

The Pitot Tube: Its Formula. William Monroe White. Describes interesting experiments made by the author, discussing the laws governing the flow of water, and the diversity of opinion as to the formula of the Pitot tube. Discussion follows. Ill. 12000 w. Jour Assn of Engng Soc's—Aug., 1901. No. 43287 C.

Plumbing.

Plumbing in the Lying-In Hospital, New York. Illustrated description of the special features of plumbing work in a hospital where unusual precautions were taken to have no seams or corners in which dust can collect. 1800 w. Eng Rec—Sept. 7, 1901. No. 43128.

Pumping.

See Electrical Engineering, Power Applications.

Pump Rig.

A Farm Pump Rig. F. A. Stanley. Brief illustrated description of a simple arrangement for pumping water. 400 w. Am Mach—Sept. 5, 1901. No. 43099.

Ram Pump.

Pearn's Compound Single-Acting Ram Pump. Brief illustrated description. 400 w. Engng—Sept. 13, 1901. No. 43346 A.

Turbines.

Recent Turbine Installations (Neuere Turbinenanlagen). Giving descriptions of recent installations by Escher, Wyss & Co., at Schaffhausen, Chèvres, Lyons, Niagara, and Kubel. Two articles. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Aug. 24, 31, 1901. No. 43414 each D.

Water-Wheels.

The Cassel Self-Regulating Water Wheel. E .C. de Segundo. Illustrates and describes this wheel explaining its action. 2100 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43284 D.

MACHINE WORKS AND FOUNDRIES.

Brace Pins.

On the Strength of Brace Pins. Discusses the different modes of failure, and the way to compute the diameter of a brace pin for a boiler staybolt. Ill. 1500 w. Locomotive—Aug., 1901. No. 43383.

Cast-Iron.

Physical Development of Malleable Cast Iron. C. Powers. Discusses the elements that effect physical standards, and the conditions to overcome. 3000 w. Foundry—Sept., 1901. No. 43048.

Coining.

How Money Is Made. Marcus Benjamin. A brief summary of the principal steps in transforming ore into coin. Ill. 2000 w. Sci Am—Sept. 7, 1901. No. 43108.

Cost-Keeping.

See Industrial Economics.

Cranes.

See Electrical Engineering, Power Applications.

Dies.

Dies for Making a Street Metal Ferrule. William Doran. Illustrates and describes dies which produce in two operations results which would usually require four. 2500 w. Am Mach—Sept. 19, 1901. No. 43322.

Engraving.

An Engraving Machine. Illustrated descriptions of a machine of English origin, used for this work. 500 w. Am Mach—Sept. 26, 1901. No. 43375.

Foundry Work.

Opportunities for Bettering the Work of the Foundry. Percy Longmuir. States conditions as they often exist, showing that poor installations are costly, and discussing points leading to satisfactory and economical results. 3800 w. The Engineering Magazine—Oct., 1901. No. 43484 B.

Gas Brackets.

Some Adjustable Gas-Brackets for Work-Shop Use. Illustrates and describes fittings manufactured in German shops. 1300 w. Jour Gas Lgt—Sept. 3, 1901. No. 43174 A.

Grinder.

The Bath Upright Type Universal and Combination Grinder. Illustrated detailed description. 1500 w. Ir Age—Sept. 5, 1901. No. 43060.

Index Table.

Complete Index Table for the Universal Milling Machine. Theo. J. Schmitz. Gives table complete for all whole numbers up to 360 divisions, which may be used for the usual method of indexing and the De Leeuw method. 500 w. Am Mach—Sept. 5, 1901. No. 43102.

Jigs.

The Jig Habit in America. Oberlin Smith. Discusses the tendency to use jigs and analogous tools for the accurate and rapid development of interchangeable parts of machines. 2800 w. Jour Fr Inst—Sept., 1901. No. 43058 D.

Metric System.

The Adoption of the Metric System in Our Work-Shops. Arthur Greenwood. Urging the adoption of the system. 2000 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43281 D.

See Civil Engineering, Measurement.

Moulding.

Moulding a Special Casting. George Buchanan. Illustrates and describes the work. 600 w. Am Mach—Sept. 26, 1901. No. 43377.

Pig Iron.

Machine Cast-Foundry Pig Iron. Albert Ladd Colby. Read before the Philadelphia Foundrymen's Assn. On the application of machine casting to foundry pig, the advantages, and difficulties, attending its introduction. Ill. 4500 w. Ir Age—Sept. 12, 1901. No. 43153.

Plows.

Cast and Chilled Plows. R. L. Ardrey. Reviews the history of this implement in America, giving an account of Juthro Wood's success with the cast plow, and James Oliver's with the chilled plow. 3000 w. Ir Age—Sept. 5, 1901. No. 43063.

Pneumatic Tools.

Pneumatic Riveting, and Other Useful Applications. J. C. Taite. An illustrated article confined principally to the work of riveting. 2200 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43277 D.

Power Press.

The Power Press in Agricultural Machine Work. William Doran. Illustrated account of work done by the power press, especially in punching heavy stock. 1900 w. Am Mach—Sept. 12, 1901. No. 43185.

Premium System.

See Industrial Economics.

Punch.

An Expansion Punch. Jos. V. Woodworth. Illustrates and describes a punch used for producing a bead on the outside of a straight drawn shell, and its operation. 1400 w. Am Mach—Sept. 5, 1901. No. 43100.

Shearing.

Shearing with Circular Shears (Cisaillage avec Lames Circulaires). M. Codron. A continuation of the author's investigation of the work of machine tools. The power required to shear various metals was determined by bell, hydraulic, steam, and electric driving. 8000 w. Bull Soc d'Encour—Aug. 31, 1901. No. 43429 G.

Sheet-Metal.

A Job of Piercing, Blanking and Forming Sheet Metal. William Doran. Illustrated description of the punch and dies used and their construction. 1700 w. Am Mach—Sept. 5, 1901. No. 43098.

Shop Methods.

Modern Systems for Shop Work. W. H. Booth. Discusses the practice in British workshops, defending its good qualities and pointing out its mistakes and where improvements are needed. 2200 w. Elec Rev, Lond—Aug. 23, 1901. No. 43026 A.

Special Methods for Machine Shop Operations (Verfahren zur Bearbeitung von Maschinenkörpern). E. Capitaine. With details of various convenient machining operations as conducted in the writer's establishment; including drilling, milling, and shaping special pieces. 2000 w. Zeitschr d Ver Deutscher Ing—Aug. 24, 1901. No. 43416 D.

Workshop Methods. William Weir and J. R. Richmond. Gives an account of schemes inaugurated to interest the staff and men of an engineering establishment in securing greater efficiency. 3300 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43276 D.

Slide Valves.

The Inertia of a Slide Valve. J. E. Cooper. Deals with the stresses caused by the reciprocating motion, and considers the best means of providing for them. 1500 w. Prac Engr—Aug. 23, 1901. No. 43020 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys of Lead and Tellurium. Henry Fay and C. B. Gillson. Concerning investigations carried out at the Inst. of Technology, Boston. Ill. 3500 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 43298 D.

Notes on Alloys of Copper and Iron. J. E. Stead. Abstract of paper read before the Glasgow Congress. Report of researches made during the last year, giving results. 5500 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43250 A.

Brasses.

Brasses. Percy Longmuir. Gives interesting information concerning the varieties of brass, the composition, treatment, etc. 1800 w. Foundry—Sept., 1901. No. 43047.

Brittleness.

The Brittleness of Steel (Sur la Fragilité de l'Acier). A. Pourcel. A review of the experiments of Frémont on bending tests of small nicked bars. 3000 w. Génie Civil—Aug. 17, 1901 No. 43400 D.

Flat-Wire.

Producing Flat Wire of Uniform Gauge. A. F. Horton. Illustrates and describes method. 1000 w. Am Mfr—Aug. 29, 1901. No. 42998.

Hardness.

Brinell's Method of Determining the Hardness and Other Properties of Iron and Steel. Axel Wahlberg. Abstract of a paper read before the Glasgow Congress. Considers the influence of chemical composition of freezing temperatures, of notches in the specimens, and of treatment. 3300 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43247 A.

Nickel Steel.

The Industrial Applications of Nickel Steel. Charles Edouard Guillaume. Gives results of the author's original work and gives predictions of their future extended applications. 3800 w. The Engineering Magazine—Oct., 1901. No. 43486 B.

Oils.

Practical Testing of Oils for Gas and Fuel Purposes. L. P. Lowe. Read before the Pacific Coast-Gas Assn. Also discussion. Concerning practical means of determining the degree of purity, and the importance of systematic inspection. 4700 w. Am Gas Lgt Jour—Sept. 9, 1901. No. 43152.

Taylor-White Process.

The Taylor-White Process of Treating Tool Steel, and Its Influence on the Mechanic Arts. Charles Day. Briefly describes the process and gives an account of the work in the shops of the Link-Belt Engng. Co., Philadelphia. 5200 w. Jour Fr Inst—Sept., 1901. No. 43055 D.

Testing Machines.

The 100-Ton Universal Testing Machine, with Variable Accumulator, at the James Watt Laboratories, Glasgow University. J. Hartley Wicksteed. Illustrated detailed description. 1900 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43283 D.

Treatment.

The Correct Treatment of Steel. C. H. Risdale. Abstract of a paper read at Glasgow Congress. Gives the writer's views, discussing the responsibility of the maker and user tests, etc. 1100 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43251 A.

Wire-Making.

The Effect of Copper on Steel for Wire-Making. J. E. Stead and F. H. Wigham. Abstract of a paper read before the Glasgow Congress. Gives analysis and a summary of the results of the author's work. 1900 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43245 A.

POWER AND TRANSMISSION.

Air Compressor.

A High Duty Air Compressor Driven by the Largest Pelton Wheel in the World. Describes arrangements at the Morning Mine, Idaho, for furnishing power for mining operations. Ill. 900 w. Am Mach—Sept. 26, 1901. No. 43376.

Driving Plant.

Power Required to Drive a Marine-Engine Works. James Crighton and W. G. Riddell. Illustrated description of some recent improvements and report of results. 2400 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43282 D.

Handling.

The Handling of Merchandise (Der Bewegung von Massengütern). A. Lemmer. Presidential address before the Kiel meeting of the Verein deutscher Ingenieure, discussing especially modern methods of handling grain cargoes. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 24, 1901. No. 43415 D.

Mechanical Conveying.

Mechanical Conveying of Coal and Coke in Gas-Works. Henri Laurain. Read at meeting of the Société Technique. Considers the hauling of the coal to the retorts and the mechanical conveying of the coke from the retorts, giving illustrations of the De Brouwer apparatus. 3800 w. Jour Gas Lgt—Sept. 3, 1901. No. 43173 A.

The Mechanical Transport of Materials in Gas-Works. William Reginald Chester. Describes the apparatus in use for transporting coal, coke, purifying material, and sulphate of ammonia. 2200 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43256 A.

Pan-American.

The Power Plants of the Pan-American Exposition. Illustrated detailed description of the sources of power for the exposition. 3300 w. Power Qr—Sept., 1901. No. 43313 C.

Traction Plant.

Compressed Air Traction Plant, Red Point Mine, Placer County, Cal. Outlines the method of mining in this gold placer. It is a horizontal deposit beneath a volcanic deposit, and the drift mining method consists in driving tunnels. Describes the traction installation. Ill. 1300 w. Min & Sci Pr—Aug. 31, 1901. No. 43103.

Variable Speed.

Variable Speed Transmitters Illustrates and describes three new devices for the positive transmission of variable speed. 2800 w. Mach, N. Y.—Sept., 1901. No. 42999.

SPECIAL MOTORS.

Alcohol.

Alcohol Motors (Les Moteurs à Alcohol). L. Périssé. An exhaustive study of the construction and operation of internal combustion motors using alcohol as fuel. 15000 w. Mem Soc Ing Civ de France—July, 1901. No. 43418 G.

Binary Engine.

The Waste-Heat Auxiliary Engine. Illustrates this engine that has been in service during the past three months at the central station of the Berlin Electrical Works, reporting the results of the tests and its standing as an economic factor in the generation of power. 2300 w. U. S. Cons Repts. No. 1139—Sept. 14, 1901. No. 43178 D.

Diesel Motor.

The Diesel Thermal Motor (Mittheilungen über den Thermischen Motor, System Diesel). R. Diesel. An address reviewing the progress of the Diesel motor, showing especially its advantages in an oil producing country as to commercial as well as thermal economy. Two articles, 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 6, 13, 1901. No. 43424 each B.

Gas Engines.

Gas Engines at the Pan-American Exposition. An illustrated description of the internal combustion engines in the pumping plant, in the court of the Machinery and Transportation Building and on exhibiton. 4500 w. Engr, U. S. A.—Sept. 15, 1901. No. 43319.

Gas Engines at the Pan-American Exposition. Illustrates and describes the engines taking part in the power supply for the exposition. 4800 w. Power—Sept., 1901. No. 43092.

Gas, Gasoline and Alcohol Motors at the Exposition of 1900 (Les Moteurs à Gaz, à Pétrole, et à Alcool à l'Exposition de 1900). G. Lavernge. The first instalment of a general description of the motors shown at the Paris Exposition. Serial. Part I. 1800 w. Génie Civil—Aug. 17, 1901. No. 43401 D.

The Buffalo Tandem Gas Engine. Illustrated description, noting the distinctive features. 1500 w. Ir Age—Sept. 5, 1901. No. 43062.

Oil Motors.

The Application of Oil Motors to Marine Work. The first of a series of articles, discussing the advantages and disadvantages of these motors. The present number considers the application to launches. 3400 w. Prac Engr—Aug. 23, 1901. Serial. 1st part. No. 43018 A.

Power Gas.

An Examination of Various Power Gases (Einiges über die zur Krafterzeugung Verwendeten Gasarten). F. Krull. An examination of the various producer and water gas processes and the relative values of the products for motive power. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 30, 1901. No. 43423 B.

The Utilisation of Blast Furnace Gases (L'Utilisation des Gaz de Haut Fourneau). J. Deschamps. A general review of the development of power by the use of furnace gases in internal combustion motors, from the first experiments of Thwaite to the present time. Mem Soc Ing Civ de France—July, 1901. No. 43419 G.

The Loomis Water-Gas and Producer-Gas Process. Illustrates and describes a plant recently installed at the works of the Winchester Repeating Arms Co., New Haven, Conn. 1700 w. Eng News—Sept. 12, 1901. No. 43190.

The Profitable Utilization of Power From Blast-Furnace Gases. B. H. Thwaite. An explanation of the system and a statement of its advantages. 1100 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43246 A.

STEAM ENGINEERING.

Blowing Engine.

Compound Blowing Engine at the Askam Iron Works. Illustrates and describes the engine and its operation. 1200 w. Engng—Sept. 13, 1901. No. 43345 A.

Boilers.

Discussion on Mr. G. M. Brown's Paper on "Some Attempts to Increase the Efficiency of Marine Boilers." 7000 w. Trans of N.-E. Coast Inst of Engrs & Shipbuilders—May, 1901. No. 42986 E.

Mr. G. M. Brown's Reply to the Discussion on His Paper on "Some Attempts to Increase the Efficiency of Marine Boilers." 1600 w. Trans of N.-E. Coast Inst of Engrs & Shipbuilders—July, 1901. No. 42990 E.

Resumed Discussion on Mr. E. Griffith's Paper on "Water-Tube Boilers." Also plates. 9600 w. Trans of N.-E. Coast Inst of Engrs & Shipbuilders—July, 1901. No. 42991 E.

The Lagosse Boiler (Les Chaudières Lagosse). With details of tests showing an evaporation of more than 10 pounds of water per pound of combustible. The device is a combined shell and water-tube boiler. 2000 w. Revue Technique—Aug. 25, 1901. No. 43412 D.

The Niclausse Boiler (Niclausse Kessel). Carl Züblin. A review of the development of the Niclausse boiler, with special reference to the marine type, giving details of construction, automatic feed, etc. Serial, Part I. 4000 w. 1 plate. Schiffbau—Sept. 8, 1901. No. 43438 D.

The Working Economy of the Steam Boiler. Charles Arthur Hague. A discussion of the disagreement of expert tests and service conditions. 4000 w. The Engineering Magazine—Oct., 1901. No. 43-487 B.

Water-Tube Boilers. Edwin Griffith. Considers the present position of water-tube boilers from the point of view of the marine engineer. Also appendix, discussion and plates. 16000 w. Trans of N.-E. Coast Inst of Engrs & Shipbuilders—May, 1901. No. 42989 E.

Boiler Explosions.

The Boiler Explosions at Sardinia Street Station. Substance of the Board of Trade report concerning these explosions which took place last winter. The boiler was of the water-tube type. Ill. 7500 w. Elect'n, Lond—Sept. 6, 1901. No. 43213 A.

Brewery Plant.

Steam Heating and Ventilating Plant of the Liesing Brewery. J. H. Klinger. Translated from *Gesundheit's Ingenieur*. Illustrated description of the building and of the steam-heating plant and the ventilating plant. 1500 w. Dom Engng—Sept. 15, 1901. No. 43316 C.

Engine Test.

Test of a Steam Engine (Expériences sur une Machine à Vapeur). J. Hirsch. A detailed account of the elaborate test by Professor Hirsch of the improved steam engine of MM. Weyher & Richemond. Serial, Part I. 5000 w. Revue de Mécanique—Aug. 31, 1901. No. 43427 E + F.

Exhaust Steam.

Note on a Regenerative Accumulator and Its Application for Using Exhaust Steam. M. A. Rateau. Illustrates and describes a new apparatus intended to allow the use of exhaust steam from machines having intermittent action, such as winding engines or the reversible engines of rolling mills. 700 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43274 D.

Expansion.

The Expansion of Steam. O. P. St. John. Presented before the Canadian Assn. of Stationary Engrs. Discusses the laws governing expansion and their results as affecting the efficiency. 2900 w. Engr, U. S. A.—Sept. 1, 1901. No. 43075

Fuel.

Pulverized Fuel. R. A. Douglass. On the preparation of this fuel and methods of burning, the advantages claimed, etc. 2400 w. Am Elect'n—Sept., 1901. No. 43066.

Furnaces.

Furnace Temperatures. W. H. Booth. Discusses points in the combustion of bituminous fuels. 2500 w. Elec Rev, Lond—Aug. 30, 1901. No. 43131 A.

Heat.

Wasted Heat. A. M. Wickens. Discusses some points relating to economical combustion. 1600 w. Can Engr—Sept., 1901. No. 43082.

Indicator Diagrams.

Some Shop Engine Indicator Diagrams. C. D. King. Gives a set of diagrams taken on a cross-compound Corliss engine, with explanatory notes. 600 w. Am Mach—Sept. 5, 1901. No. 43101.

Theoretical Indicator and Valve Diagrams and Their Relation to Marine Engine Design. Theodore Lucas. Explains the great value of diagrams to engine designers in settling rapidly and efficiently many points to be considered. Ill. 1500 w. Marine Engng—Sept., 1901. No. 43-070 C.

Lubrication.

A Lubrication Regulator. From *La Nature*. Illustrates and describes an apparatus designed by M. Caloin, giving automatic lubrication for the entire engine, and possessing many advantages. 1100 w. Sci Am Sup—Sept. 21, 1901. No. 43326.

Marine Engines.

Some Facts Affecting the Economical Manufacture of Marine Engines. William

Thomson. Considers the premium system, good tools, arrangement, shop conditions, and standardization. 3200 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43275 D.

Orifices.

Experiments on the Escape of Steam Through Orifices. M. A. Rateau. An illustrated report of results obtained in experimental investigations. 1100 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43272 D.

Petroleum.

Petroleum as Fuel. From an article by A. Adiassewich in *Fairplay*. Gives some reasons why it can be regarded as a competitor of coal, experimental determinations of its heating value, etc. 2000 w. Marine Rev—Sept. 5, 1901. No. 43116.

Steam Heating.

Systems of Heating by Steam. H. H. Kelley. Illustrated description of the various systems of steam heating employed in buildings and residences. 2500 w. Engr, U. S. A.—Sept. 1, 1901. Serial. 1st part. No. 43076.

Steam Meter.

The Gehre Steam Meter (Compteur de Vapeur, Système Gehre). Ch. Dantin. A description of the Gehre Meter for measuring the flow of steam by regulating the opening, according to Napier's law. A recording attachment is included. 2000 w. Génie Civil—Aug. 31, 1901. No. 43406 D.

Steam Plant.

The Steam Plant in the Atlantic Mutual Building, New York. Illustrated description of the power plant in an 18-story office building, giving details of the machinery, extracts from the specifications, and general features of the electrical installation. 5000 w. Eng Rec—Sept. 7, 1901. No. 43121.

Steam Tables.

Steam Tables. Charles L. Hubbard. Explains some of the principles of heat and steam and the application of steam tables to practical examples in engineering. 2500 w. Am Elect'n—Sept., 1901. No. 43065.

Steam Turbines.

Trials of Steam Turbines for Driving Dynamos. Charles A. Parsons, and G. Gerald Stoney. Tabulated results of tests are given, with illustrations and description of latest improvements. 2200 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43273 D.

Superheating.

Superheated Steam. O. Herre. Explains the manner of superheating, and gives tabulated information showing the economy effected. 800 w. Power—Sept., 1901. No. 43091.

Some Experiences and Results Derived From the Use of Highly Superheated Steam in Engines. R. Lenke. 2300 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43278 D.

The Schmidt System of Superheating Steam. Illustrates and describes the Schmidt patent "direct-fired" superheater, and the flue-fired superheater. Also the Schmidt single-acting tandem compound condensing engine. 2800 w. Ir & Coal Trds Rev—Aug. 30, 1901. No. 43135 A.

Water Columns.

Water Column Connections. C. W. Obert. An account of the results of false practice in method of connecting up water columns for steam gauge and water-glass connection to boilers. 600 w. Am Elect'n —Sept., 1901. No. 43068.

MISCELLANY.

Address.

The Art and Craft of the Machine. Frank Lloyd Wright. The address deals chiefly with the effect of the machine on architecture, and that it should be made evident that it is a help in the line of progress to the very best work possible for men. 9000 w. Jour W Soc of Engrs—Aug., 1901. No. 43053 D.

Agricultural Machinery.

Agricultural Machinery in the Canadian Pavilion at the Glasgow International Exhibition, 1901. G. Harwood Frost. Illustrated descriptions of harrows, cultivators, harvesters, mowers, etc., etc. 7000 w. Inst of Mech Engrs—Glasgow Congress, 1901. No. 43271 D.

Bicycles.

Bicycle Construction (Les Bicyclettes). C. Bourlet. The first of a series discussing "free" wheels, brakes and variable speed gears for bicycles. Serial, Part I. 1500 w. Génie Civil—Sept. 7, 1901. No. 43408 D.

Church Heating.

Ventilating and Heating St. Mark's Church, Baltimore. The hot air is distributed under a plenum system assisted by aspiration near the exits. The ventilation is an upward one with air delivery through a large number of small openings in the ends of the various pews. Ill. 1800 w. Eng Rec—Sept. 14, 1901. No. 43269.

Enamelling.

Enamelling. The first of a series of articles on the commercial enamelling industry, considering hollow-ware enamelling for domestic use, and for chemical use, enamelling locomotive and other tubes, drain and water pipes, and sign-board enamelling. 4200 w. Engr, Lond—Aug. 23, 1901. Serial. 1st part. No. 43041 A.

Glasgow.

The Rise and Progress of Glasgow Industries. A review of the more important industries of the city. 5000 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43234 A.

Guns.

New 5-Inch Segmental Wire-Wound Gun for the United States Army. Illustrates and describes the process of manufacture, and gives information of interest. Also editorial. 3200 w. Sci Am—Sept. 7, 1901. No. 43107.

Heating Plant.

Ventilation and Heating in the Merchants' Loan and Trust Building, Chicago. Describes the plant of a 12-story office building. It is warmed by steam, distributed by means of the downward system of piping with gravity return; a vacuum system of circulation and automatic temperature regulation, and ventilated in the lower stories by a plenum and exhaust system. Ill. 2700 w. Eng Rec—Sept. 21, 1901. No. 43370.

Ice Plant.

A Model Ice-Making Plant. Illustrated description of a plant in Waynesboro, Pa. 1200 w. Ice & Refrig—Sept., 1901. No. 43085 C.

Kinematics.

The General Principles of Mechanism (Sur les Principes Généraux des Mécanismes). G. Koenigs. A communication to the French Academy, criticising some details of the kinematic analysis of machines by Prof. Reuleaux. 1200 w. Comptes Rendus—Aug. 19, 1901. No. 43431 D.

Refrigeration.

The Ammonia Compression System. T. F. Andersen. Abstract of a lecture before Illinois No. 28. Discusses points of importance in securing economy and efficiency. 2200 w. Compressed Air—Sept., 1901. No. 43286.

School Heating.

Ventilation and Heating of Friendship School, Pittsburg. Illustrated description of an unusually costly plant taking air from an inlet 60 ft. from the building and avoiding the use of galvanized ducts in the basement by employing underground flues. 1500 w. Eng Rec—Sept. 7, 1901. No. 43126.

MINING AND METALLURGY

COAL AND COKE.

Briquettes.

Lignite and Peat Briquettes in Germany. Concerning the efforts made to utilize the turf beds with an account of the Stauber process of making briquettes. 700 w. U. S. Cons Repts, No. 1142—Sept. 21, 1901. No. 43310 D.

Brown Coal.

The Brown Coal Industry of Germany and Austria. A résumé of the report of James Stirling, giving information of the principal mining areas in the countries named. Ill. 3700 w. Ir & Coal Trds Rev—Aug. 23, 1901—No. 43032 A.

By-Products.

The Development of the By-Product Coking Industry. William Gilbert Irwin. An illustrated article reviewing the systems evolved in Europe and recently in America. 5200 w. The Engineering Magazine—Oct., 1901. No. 43483 B.

China.

The Coal-Fields of Northeastern China. Noah Fields Drake. An account of the K'ai-p'ing, P'ing-Ting and Tsê Chou fields, with general remarks and illustrations. 5600 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 43290 D.

Coal Developments.

Anglo-Chinese Coal Developments. Editorial on the transfer of the Kai-ping coal mines in Northern China, from a native to an English company, and the immense deposits. 1200 w. Engng—Aug. 23, 1901. No. 43037 A.

Coke-Making.

Coke-Making at the Olion Coke-Works. Fred C. Keighley. Illustrates and describes these works in Pennsylvania. 2200 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43252 A.

Germany.

The General Coal Industry: Syndicates and Government Mines. Discusses the questions relating to this industry which are being considered. The new tariff, etc. 2000 w. Col Guard—Aug. 30, 1901. No. 43139 A.

Haulage.

Adjustable Turntable for Haulage Inclines. From *Glückauf.* Drawings and description of an arrangement introduced to overcome the difficulties attending the switching of tubs in and out of haulage inclines. 7000 w. Col Guard—Aug. 30, 1901. No. 43138 A.

Origin.

The Origin of Coal. Reviews the theory set forth by Aubrey Strahan in a paper read at a meeting of the Geol. Soc. 1400 w. Engng—Aug. 23, 1901. No. 43034 A.

Subsidences.

Coal-Mining Subsidences in Relation to Sewerage Works. F. W. Mayer. Directs attention to the irregular nature of the protection against subsidencies from mining operations. 1000 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43255 A.

Surface Plant.

Coal Tipple and Cantilever Bridge Over Tygart's Valley River, Near Fairmont, W. Va. Illustrates and describes details of a new surface plant for operating coal mines. 900 w. Eng News—Sept. 19, 1901. No. 43329.

Wages.

See Industrial Economics.

Washing.

Coal Washing. D. F. Cameron. An illustrated description of the coal-washing plant of the Donk Brothers Coal & Coke Co., at Collinsville. Ill. 3800 w. Mines & Min—Sept., 1901. No. 43094 C.

West Lothian.

The Carboniferous Limestone Coal-Fields of the West Lothian. Henry M. Cadell. Abstract of a paper read before the Glasgow Congress. Describes the seams and gives diagrams. 1200 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43253A.

Winding.

Reserve Winding Gear at German Collieries. From *Zeitschrift für Berg. Hutten und Salinenwesen.* Illustrates and describes arrangements erected to ensure continuity of coal-raising in the event of accident to the main winding gear. 600 w. Col Guard—Aug. 30, 1901. No. 43137 A.

COPPER.

Arizona.

Arizona Copper. Joseph Hyde Pratt. An illustrated article. Part first deals with the general occurrences. 2500 w. Min & Met—Sept. 1, 1901. Serial. 1st part. No. 43079.

Developments.

Copper Developments. Editorial discussion of the present situation and future outlook, and the steps being considered to maintain the price of this product. 1100 w. Engng—Aug. 23, 1901. No. 43035 A.

Japan.

The Copper Mines of Ashio, Japan. Edwin G. Adams, Jr. An illustrated article showing the effect of abandoning the old methods and the rapid increase of production under native engineering management. 1500 w. The Engineering Magazine—Oct., 1901. No. 43485 B.

GOLD AND SILVER.

Africa.

African Mines and Mining. Arthur Stanley Riggs. An illustrated account of the gold, diamond and other mineral fields, and the mining industry in general. 3500 w. Min & Met—Sept. 1, 1901. No. 43078 C.

Alaska.

Ketchikan Mining District, Alaska. An account of this region describing the mines already located. Copper, gold, lead and silver are found. Map. 8500 w. Min & Sci Pr—Sept. 7, 1901. No. 43159.

Georgia.

The Crown Mountain Gold Mine and Mill, Georgia. Henry V. Maxwell. Illustrates and describes a plant combining the old and new methods in mining and saving the gold contents of low-grade ores. It combines mining, milling and sluicing, and utilizes water-power in generating and transmitting electrically the power needed. 1200 w. Eng & Min Jour—Sept. 21, 1901. No. 43359.

Gold Dredging.

Dredging for Gold in New Zealand. Raymond Payne. An illustrated account of the methods and success attained. 1900 w. Eng & Min Jour—Sept. 28, 1901. No. 43391.

Gold-Dredging Possibilities on the North Thompson River Near Kamloops, B. C. John Redmond. Discusses the possibility of profitable dredging. 2000 w. B. C. Min Rec—Sept., 1901. No. 43176 C.

Ore Deposits.

The Sierra Mojada, Coahuila, Mexico, and Its Ore-Deposits. James W. Malcolmson. Gives the history and development of the Sierra Mojada mines, the character and extent of the ore-deposits, and the methods of mining. Ill. 10600 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 43296 D.

Ore Treatment.

Ore Treatment in Victoria. Donald Clark. Illustrates and describes the South German cyanide plant at Maldon. 1800 w. Aust. Min Stand—Aug. 8, 1901. No. 43146 B.

Philippines.

Notes on the Pigholugan and Pigtao Gold-Regions, Island of Mindanao, Philippine Islands. J. Clayton Nichols. Descriptive. 2200 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 43300 D.

Rhodesia.

Mining in Rhodesia. Cyril E. Parsons. Reviews the conditions and present output of this gold field. 1100 w. Eng & Min Jour—Aug. 31, 1901. No. 43002.

Sampling.

Sampling Mill Work. Jesse Scobey. Discusses prevalent systems, and the importance of the records, describing a method devised by the writer. 2100 w. Min & Sci Pr—Sept. 21, 1901. No. 43387.

IRON AND STEEL.

Bessemer Flames.

An Investigation of the Spectra of Flames at Different Periods During the Basic Bessemer Blow. W. N. Hartley and Hugh Ramage. Abstract of a paper read before the Glasgow Congress. Gives description of the blow and over-blow, the spectrum of the over-blow, and conclusions. 4500 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43244 A.

Canada.

Iron and Steel Making in Ontario, Canada. Reviews the recent development of this industry, and describes some of the plants. 3400 w. Ir & Coal Trds Rev—Aug. 23, 1901. No. 43031 A.

Ferro-Alloys.

The Presence of Calcium in High Grade Ferro-Silicon. G. Watson Gray. Abstract of a paper read before the Glasgow Congress. Gives analysis of ferro-silicons containing calcium, describing work. 1500 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43243 A.

Internal Strains.

The Internal Strains of Iron and Steel and Their Bearing Upon Fracture. Arthur Wringham. Abstract of a paper read before the Glasgow Congress. Studies the behavior of metals and unexpected breakages. 5600 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43249 A.

Japan.

The Japanese Iron Industry. An illustrated description of the smaller works in Japan, producing iron and steel in the old fashioned way and which has furnished the famed sword steel of the Japanese. 1000 w. Col Guard—Sept. 6, 1901. No. 43220 A.

Pig Iron.

A Crystalline Sulphide in Pig-Iron. Andrew A. Blair and Porter W. Shriner. Describes investigations to isolate a suspected insoluble sulphide. 800 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 43293 D.

The Cost of Producing Pig Iron in the United States. William B. Phillips. Discusses the cost in various districts and compares the results with foreign countries. 2500 w. Eng & Min Jour—Aug. 31, 1901. No. 43003.

Rod Mill.

Efficiency Test of a Continuous Rod Mill. Describes the plant and test of a Morgan continuous rod mill. Ill. 2000 w. Ir Age—Sept. 12, 1901. No. 43154.

Scotland.

Iron and Steel Industries of the West of Scotland. I. Henry Burnby. II. William Wylie. Discusses pig and malleable iron industries, the materials, bye-products, etc. 4500 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43242 A.

Slag.

Disintegrating Blast Furnace Slag. A. D. Elbers. Explains the phenomenon of slag disintegrating by its own heat. 1800 w. Am Mfr—Sept. 5, 1901. No. 43110.

Steel Billets.

Variations of Carbon and Phosphorus in Steel Billets. Axel Wohlberg. Abstract of paper read before the Glasgow Congress. Gives the plan of the researches, the results and conclusions. 2800 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43248 A.

MINING.

Boring.

Deep Borings at the Rheinpreussen Mine (Tiefbohrverfahren der Zeche Rheinpreussen). H. Mentzel. With description of the machines and table of the borings at the Rheinpreussen mine, near Homberg. 1000 w. 1 plate. Glückauf—Aug. 31, 1901. No. 43461 B.

Mechanics of Oil Well Boring. A brief analysis of the arts of well-boring and related matters; describing systems used in America. Ill. 1500 w. Am Gas Lgt Jour —Sept. 23, 1901. No. 43363.

Colorado.

The Tragedy of the Homestake Mine, Colorado. W. H. C. Butler. Historical account of the discovery and early working. Ill. 1500 w. Min Rept—Sept. 19, 1901. Serial. 1st part. No. 43354.

Concentration.

Concentrating Systems. Editorial remarks on methods to meet the requirements of different districts and special ores. 1500 w. Eng & Min Jour—Sept. 14, 1901. No. 43181.

Concentrating Zinc-Lead Ores in the Galena Joplin District of Missouri. W. R. Crane. Describes the methods of milling and separating the pyrites. Ill. 2000 w. Mines & Min—Sept., 1901. No. 43096 C.

The Waring System of Magnetic Concentration. Outlines the five types of magnetic separators that have been tried, and gives an illustrated description of the system named. It is in use for the purification of zinc blende ores, the extraction of blende from pyritic jig stuff, and for the separation of pure zinc, copper and iron material from complex sulphide ores. 2000 w. Eng & Min Jour—Sept. 14, 1901. No. 43184.

Diamond Drill.

Electrically Driven Diamond Drill (Perforatrice à Diamants et à Commande Electrique). An illustrated description of the Fromholt electric drill for mining, quarrying, and tunnelling. 1200 w. Génie Civil —Sept. 7, 1901. No. 43410 D.

Emergency Valve.

A New Emergency Straightway Gate Valve. A. F. Lucas. Illustrated description of a valve used in closing an oil well near Beaumont, Texas. 600 w. Eng & Min Jour—Sept. 21, 1901. No. 43360.

Explosives.

Annual Report on Explosives. Extracts from the report of the Inspectors of Explosives for the year 1900. 2200 w. Engr, Lond—Aug. 23, 1901. No. 43042 A.

Firedamp.

Firedamp Explosions on the Surface (Schlagwetterexplosionen über Tage). H. Einecker. An account of an explosion of fire damp on the surface of the earth, being in the washing tower of the Dahlbusch colliery near Ratthausen, East Essen. 1200 w. Glückauf—Aug. 17, 1901. No. 43-457 B.

Galena-Joplin District.

Methods of Prospecting and Mining in the Galena-Joplin District. W. R. Crane. Discusses the character and origin of the deposits; the prospecting by shafts and by drills; method of mining. with details; and method of drifting. 4000 w. Eng & Min Jour—Sept. 21, 1901. No. 43362.

"Hole Contract."

The Operation of the "Hole Contract" System in the Center Star and War Eagle Mines, Rossland, B. C. Carl R. Davis. Explains why the system was introduced, the details, advantages and disadvantages of the system. 2200 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 43294 D.

Mining Report.

Mining Labor and Accidents for the Year 1900. Part II. of Dr. Foster's General Report, containing valuable information concerning the labor conditions. 4500 w. Col Guard—Aug. 30, 1901. No. 43136 A.

Ore Dumps.

The Treatment of Ore Dumps in Cornwall. Edward Skewes. Describes the present conditions of the tin mining districts of Great Britain, and the working of the dumps for the lead and silver, and the various other products formerly considered valueless. 800 w. Eng & Min Jour—Sept. 14, 1901. No. 43183.

Ores.

Some Principles Controlling the Deposition of Ores. C. R. Van Hise. Concluding contribution of Prof. Van Hise to the discussion of his paper. 7400 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 43292 D.

Pan-American.

Mining at the Pan-American Exposition. A description of the geological and mining exhibits. Ill. 4500 w. Mines & Min —Sept., 1901. No. 43093 C.

Prussia.

The Development of Mining in Prussia in 1900 (Versuche und Verbesserungen beim Bergwerksbetriebe in Preussen während des Jahres 1900). Discussing especially explosives and coal cutting machinery. 1800 w. Glückauf—Aug. 17, 1901. No. 43458 B.

Rock Drill.

The Triumph Rock Drill of the Ruhrthaler Machine Works (Die Gesteinsbohrmaschine "Triumph" der Ruhrthaler Maschinenfabrik). Describing an improved form of reciprocating pneumatic rock drill for mining. 1500 w. 1 plate. Glückauf—Aug. 24, 1901. No. 43459 B.

Safety Clutch.

Hydraulic Brake Safety Clutch for Mine Cages. R. A. Henry, in *Glückauf*. Illustrated description of the apparatus and its operation. 1100 w. Col Guard—Aug. 23, 1901. No. 43043 A.

Shaft Sinking.

Shaft Sinking at Ronnenberg, Hannover. (Das Schacltabteufen bei Ronnenberg, Hanover). H. Wiese. Describing the application of the Poetsch freezing process to deep shaft sinking. 2000 w. Glückauf—Aug. 24, 1901. No. 43460 B.

Smelting.

Chromite as a Hearth-Lining for a Furnace Smelting Copper Ore. William Glenn. Describes a chromite cupola-bottom which has done good service for nearly two years. Ill. 1800 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 43295 D.

Views of an Old Smelter in the State of Morelos, Mexico. C. W. Pritchett. Illustrations and brief notes. 600 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 43299 D.

Telluride Quadrangle.

Recent Geological Phenomena in the "Telluride Quadrangle" of the U. S. Geological Survey in Colorado. H. C. Lay. A record of observations, made during eighteen years, of local phenomena. 3500 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 43291 D.

Zinc Mines.

The Missouri and Arkansas Zinc-Mines at the Close of 1900. Eric Hedburg. Describes the situation of this industry, reviewing briefly the history and giving statistical information. 9500 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 43-289 D.

MISCELLANY.

Banxite.

The Occurrence of Banxite in Colorado and Wyoming and Its Utilization. J. Ohly. Information concerning these valuable deposits. 1100 w. Min Rept—Sept. 12, 1901. Serial. 1st part. No. 43261.

Biography.

Biographical Notice of Richard P. Rothwell, C. E., M. E. R. W. Raymond. 5500 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 43297 D.

Minerals.

Colonial Minerals at the Glasgow Exhibition. The present article notices the mineral products of most interest from Rhodesia and Queensland. 2300 w. Col Guard—Aug. 23, 1901. Serial. 1st part. No. 43044 A.

Petroleum.

Petroleum and Natural Gas in Kansas. Erasmus Haworth. Considers the geographical extent, the methods and expense of drilling, and the business methods. 1800 w. Eng & Min Jour—Sept. 28, 1901. No. 43390.

Petroleum in Western North America. Arthur Lakes. Describes the various conditions under which it occurs and where it may be expected. 3800 w. Mines & Min—Sept., 1901. No. 43097 C.

The Petroleum Fields of Wyoming. W. C. Knight. This first article of a series reviews the early history, and gives a general statement concerning the occurrence of petroleum in this state. 1800 w. Eng & Min Jour—Sept. 21, 1901. Serial. 1st part. No. 43361.

The Uses of Petroleum and Natural Gas in Kansas. Erasmus Haworth. An account of the various enterprises established in Kansas on account of the abundant and cheap fuel found there; the amount of gas they consume, etc. 1200 w. Eng & Min Jour—Sept. 14, 1901. No. 43182.

See Mechanical Engineering, Steam Engineering.

Quarrying.

A Central Compressed Air Power Plant for Quarrying. Illustrates and describes a recently installed plant for furnishing power to drive machinery in quarries. 1500 w. Ir Age—Sept. 5, 1901. No. 43061.

Tin.

Recovery of Tin From Tin-Plate Clippings. Jas. W. Worsey. Describes the process used by the writer, and the results. 1100 w. Min & Sci Pr—Sept. 21, 1901. No. 43388.

Some Methods of Tungsten Determinations. George M. Parker. Abstract of a graduation thesis at the Univ. of Arizona. An explanation of methods, and results. 1500 w. Min & Met—Sept. 1, 1901. No. 43080.

RAILWAYS AND TRAMWAYS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in July. Monthly statement of accidents in the order of the dates of their occurrence. 3000 w. R R Gaz—Sept. 27, 1901. No. 43396.

High Speed.

The Cost of Running Trains at High Speed. John G. Crawford. A study of the results of tests made on the Chicago, Burlington & Quincy R. R. during July, 1900. 1200 w. Eng News—Sept. 12, 1901. No. 43193.

Scotland.

Notes From Scotland. Alexander F. Sinclair. Discusses the acceleration of speed in London to Edinburgh trains, and the Knottingley accident. 1100 w. Loc Engng—Sept., 1901. No. 42995 C.

FINANCIAL.

Fares.

Cheaper Railway Fares. Horace Bell. Abstract of a paper read before the Glasgow Congress. Discusses the need of reduction in the United Kingdom. 1600 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43237 A.

Rating.

Rating of Street Tramways. J. Neville Porter. Some cases of British law, and a discussion of the methods of valuation. 2300 w. Tram & Ry Wld—Aug. 8, 1901. No. 43086 B.

MOTIVE POWER AND EQUIPMENT.

Air Motors.

The New Compressed Air Motors for City Traction. An illustrated account of the changes and improvements recently made, with report of their successful working. 1800 w. R R Gaz—Sept. 6, 1901. No. 43157.

Burgdorf-Thun.

The Burgdorf-Thun Electric Railway (Le Chemin de Fer Electrique de Berthoud à Thoune). M. Maguin. A general description of this important installation of polyphase traction in Switzerland, with details of the trials. 4000 w. Revue

Gen des Chemins de Fer—Sept., 1901. No. 43434 H.

Cars.

A New Convertible Hopper and Gondola Car. Illustrates and describes a car especially designed for ballasting, which can be changed into an ordinary flat-bottom gondola car capable of carrying 84,000 lbs. of coal. 900 w. R R Gaz—Sept. 20, 1901. No. 43334.

Fifty-Ton Steel Drop-Bottom Gondolas. Illustrated description of cars now building for the Elgin, Joliet & Eastern R. R. 700 w. Am Engr & R R Jour—Sept., 1901. No. 43006 C.

Compounding.

A Review of the Different Systems of Compounding. F. F. Gaines. Reviews the mechanical features. 900 w. R R Gaz—Sept. 27, 1901. No. 43394.

Electric Driving.

Electricity as a Motive Power on Railways. Prof. C. A. Carus-Wilson. Read before the Glasgow Congress. Deals with the economic considerations governing the substitution of electricity for steam as a motive power on railways. 2700 w. Engng —Sept. 6, 1901. No. 43227 A.

Electric Locomotive.

Combined Rack and Adhesion Locomotive (Locomotive à Crémaillère et à Adhérence). F. Barbier. Description of narrow gauge electric locomotive used on the road between Lyons and the plateau of Saint-Just. There are two sets of motors for the rack and adhesion respectively. 1800 w. Génie Civil—Aug. 31, 1901. No. 43405 D.

Europe.

European Railroad Jottings. Charles Rous-Marten. Discusses late locomotives in Great Britain. 1800 w. Loc Engng—Sept., 1901. No. 42996 C.

Fender.

Movable Fender for Tramways (Chasse-Corps Mobile à Déclenchement pour Tramways). Ch. Dantin. The fender is normally carried on rollers, close to the ground, but can be lifted over obstructions. 1200 w. Génie Civil—Sept. 7, 1901. No. 43409 D.

Fuel Oil.

Some Details of Fuel Oil Burners. Extracts from a paper of W. N. Best recording his experience, and describing his apparatus. Ill. 2600 w. Am Engr & R R Jour—Sept., 1901. No. 43008 C.

High Speed.

Electric High Speed Railways (Elektrische Schnellbahnen). W. Reichel. An account of the equipment of the electric railway to make 200 kilometres per hour on the Marienfeldezossen line. Serial. Part I. 5000 w. Elektrotech Zeitschr—Aug. 22, 1901. No. 43454 B.

High-Speed Electric Railway Car of the Allgemeine Elektricitats Gesellschaft, Berlin. O. Lasche. An illustrated account of the arrangements being made for the study of the economy of the electric system as compared with steam, and the speed possibilities. The trials will be made on the military railway track, Berlin-Zossen. 4500 w. Elec Wld & Engr—Sept. 14, 1901. No. 43188.

The High-Speed Cars of the General Electric Company of Berlin (Der Schnellbahnwagen der Allgemeinen Elektricitäts-Gesellschaft, Berlin). O. Lasche. A very complete description of the electric motor cars and machinery for the new express railway, to make 200 kilometres an hour. Two articles. 7000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Sept. 7, 14, 1901. No. 43417 each D.

The Zossen Polyphase Railway Installation for Experimental Trials with Speeds Up to 125 Miles an Hour. Walter Reichel. Describes a high-speed railway and experimental cars, power requirements, and details of a trial road about 14¼ miles in length. Ill. 4000 w. Elec Wld & Engr—Sept. 7, 1901. No. 43160.

Locomotive Efficiency.

The Efficiency of Locomotives (Rendement des Locomotives). J. Nadal. A discussion of the mathematical formula for efficiency, with applications to various types of simple and compound locomotives. 15000 w. Rev Gen des Chemins de Fer—Sept., 1901. No. 43436 H.

Locomotives.

A Locomotive Curiosity. Brief illustrated description of an engine built in 1846 and but recently withdrawn from service in England. 500 w. Sci Am—Sept. 28, 1901. No. 43378.

American and English Locomotives in Japan. Clippings from the Kobé Herald giving views of the Sanyo Ry. Co. relative to the respective merits of English and American locomotives. 1600 w. U S Cons Repts, No. 1137—Sept. 12, 1901. No. 43150 D.

American Locomotives in Europe. Discusses the attitude of Germany and the countries where opportunities are most promising. 1200 w. U S Cons Repts, No. 1132. Sept. 6, 1901. No. 43046 D.

A New Coal Locomotive. Sectional views and elevation with description and dimensions of an eight-coupled goods engine. 900 w. Engr, Lond—Sept. 6, 1901. No. 43222 A.

Atlantic Type Passenger Locomotives —Chicago, Milwaukee & St. Paul Ry. Illustrates the principal features of the design and the boiler and frame details and gives the general specifications. 500 w. R R Gaz—Sept. 20, 1901. No. 43332.

Consolidation Mountain Pushing Locomotive. Illustrated description of an engine for service on the Atchison, Topeka & Santa Fe Railway. Dimensions are given. 500 w. Am Engr & R R Jour—Sept., 1901. No. 43007 C.

Four Cylinder Compound Express Locomotive (Locomotive Compound à Grand Vitesse à Quatre Cylinders). D. Bellet. Illustrated description of the 66 ton express compound locomotives of the Italian Adriatic Railway. 2000 w. Revue Technique—Aug. 25, 1901. No. 43411 D.

Four-Cylinder Tandem Compound Locomotive. Half-tone drawings with description and general dimensions. The type has been found satisfactory after a year of service on the Northern Pacific Ry. and an order for 26 engines has been given. 1600 w. Am Engr & R. R. Jour—Sept., 1901. No. 43005 C.

Locomotives of the Nineteenth and Twentieth Centuries. S. M. Vauclain. Read before the New England R. R. Club. An interesting illustrated review of the history of locomotive building, with questions and replies following. 10200 w. Loc Firemen's Mag—Sept., 1901. No. 43059.

Narrow-Gauge Side-Track Locomotive for the Egyptian Delta Railway. Illustrations of a four-coupled engine with a four-wheel bogie in front. Brief description. 250 w. Engng—Sept. 6, 1901. No. 43225 A.

Schenectady Four-Cylinder Tandem Compound Locomotives—Classes Y-2 and Y-3, Northern Pacific Railway. An illustrated detailed description of a locomotive design of unsual interest, with additional comment. 3200 w. R R Gaz—Aug. 30, 1901. No. 43015.

Some Particulars of the Results of the Compound Locomotive on the Buenos Aires Great Southern Railway. R. Gould. Read before the Inst. of Mech. Engrs. Detailed description of the engines, with tabulated report of coal consumption and cost of repairs. Ill. 1900 w. Inst of Mech Engrs—Glasgow Eng, 1901. No. 43270 D.

Tandem Compound Consolidation Locomotive, Northern Pacific Ry. Illustration and principal dimensions of the Y-2 engines, with description of details. 900 w. Ry & Engng Rev—Sept. 21, 1901. No. 43365.

The Austrian Locomotives at the Exposition of 1900 (Les Locomotives Autrichiennes à l' Exposition de 1900). F. Barbier. Giving detailed dimensions of the engines exhibited, and data concerning their construction and performance. 7000 w. 2 plates. Rev Gen des Chemins de Fer—July, 1901. No. 43433 H.

The English Locomotives at the Exposition of 1900 (Les Locomotives Anglaises à l'Exposition de 1900). R. Godfernaux. With plates showing constructive details of the principal engines exhibited. 5000 w. 5 plates. Rev Gen des Chemins de Fer—Sept., 1901. No. 43435H.

Vanderbilt-Baldwin Consolidation Locomotive—Buffalo, Rochester & Pittsburg Railway. Photograph, drawings and general specifications. 1500 w. R R Gaz—Sept. 13, 1901. No. 43204.

Platforms.

Street Car Platforms. W. E. Partridge. Outlines the development of the modern car from the stage coach, and gives illustrated descriptions of the style and construction of the various platforms in use. 6000 w. St Ry Jour—Sept. 7, 1901. No. 43163 D.

Royal Train.

The Royal Train of the Canadian Pacific. Illustrated description of the train built for the use of the Duke and Duchess of York during their Canadian tour. 800 w. R R Gaz—Sept. 20, 1901. No. 43333.

Staybolts.

Locomotive Firebox Staybolts (Les Entretoises de Foyers de Locomotives). Discussing the practice of the Northern Railway of France with the "Stone" slotted staybolts, designed to secure flexibility with minimum reduction in strength. 1800 w. Revue Technique—Aug. 25, 1901. No. 43413 D.

Tender.

Tender of 6,000 Gallons Capacity—Michigan Central Railway. Illustrated description of a recent design to be used with consolidation engines now building. 800 w. R R Gaz—Sept. 6, 1901. No. 43158.

Train Control.

The Thomson-Houston System of Train Control. Illustrates and describes a train on the extension of the French Western Railway into Paris, which has been recently equipped with this multiple control system. 2200 w. Elect'n, Lond. Sept. 6, 1901. No. 42211 A.

NEW PROJECTS.

Barry.

The Rhymney Branch of the Barry Railway. Illustrates and describes an important new coal line which connects the Barry dock with the coalfields of South Wales. 1800 w. Transport—Sept. 6, 1901. No. 43218 A.

Contest.

The Struggle for the Line from Salt Lake to Los Angeles and San Diego. An account of the progress of work on these contested lines from Utah to Southern California, and the injunction which has interrupted the building. Map. 2200 w. R R Gaz—Sept. 13, 1901. No. 43206.

London.

The Rapid Transit Problem in London. Frank J. Sprague. Outlines a scheme for operating the roads electrically under a single complete plan, the abolishment of classes, establishment of one regular rate of fare, &c. Ill. 4000 w. The Engineering Magazine—Oct., 1901. No. 43480 B.

Sudan.

Sudan Government Military Railways. C. B Macauley Abstract of a paper read before the Glasgow Congress Gives details of the Khartoum and Kerma lines, and their equipment 1600 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43238 A.

PERMANENT WAY AND BUILDINGS.

Australia.

Australian Railways. W. C. Kernot. Abstract of a paper read before the Glasgow Congress. A report of the railway system and their condition, with map. 1000 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43236 A.

Brazil.

The System of the Sao Paulo Tramway, Light & Power Company, Ltd. A statement of the conditions to be met with a general review of the situation, describing the electric plant and its construction. Ill. 5800 w. St Ry Jour—Sept. 7, 1901. No. 43165 D.

Curves.

Transition Curves. W. B. Lee. A mathematical study of the cubic parabola. 600 w. Pro Am Soc of Civ Engrs—Aug., 1901. No. 42976 E.

Electric Railways.

Recent Practice in Electric Railway Construction and Operation. Editorial discussion of cost and the construction suitable for the conditions to be met. 2700 w. Eng News—Aug. 29, 1901. No. 43013.

Electrolysis.

See Gas Works Engineering.

Freight House.

A Modern Freight House, Wisconsin Central Ry. Illustrated detailed description of one of the best freight houses of modern construction and its equipment. The building is two-stories. 3300 w. Ry & Engng Rev—Sept. 14, 1901. No. 43263.

Grades.

The Construction of the Benton Cut on the Great Northern Railway, Montana. George H. Herrold. An illustrated account of heavy work accomplished during the past year. 1200 w. Eng News—Sept. 12, 1901. No. 43192.

Joints.

Rail Joints. Extracts from the *Bulletin* of the International Railway Congress, giving the essentials of the discussion of the report on rail joints. 3000 w. R R Gaz—Aug. 30, 1901. No. 43017.

Lap Sidings.

Lap Sidings on the Cleveland & Pittsburgh. L. F. Loree. Reprint of an article published Dec. 26, 1900, which has been inquired for, but was out of print. A statement of the situation and account of the "lap sidings" with diagrams. 2400 w. R R Gaz—Sept. 13, 1901. No. 43203.

Massachusetts Ry.

A Long Electric Railway in Massachusetts. Alton D. Adams. Describes the line to be constructed between Great Barrington and Cheshire. 900 w. Elec Wld & Engr—Aug. 31, 1901. No. 43010.

Norfolk, Va.

The System of the Norfolk & Atlantic Terminal Company. Illustrated detailed description of the plant with report of the service, and the conditions to be met, and the various interests of the company. 4200 w. St Ry Jour—Sept. 7, 1901. No. 43162 D.

Ontario.

The Niagara, St. Catharines & Toronto Railway. E. F. Seixas. An illustrated description of a road changed from steam to electricity. 1500 w. St Ry Jour—Sept. 7, 1901. No. 43167 D.

Overhead Construction.

Dangers from Trolley Wires and Their Prevention. Andrew Jamieson. Abstract of paper read before the Elec. Sec. of the Glasgow Cong. Considers the necessity of the proper protection of trolley wires from contact with other overhead conductors; methods adopted and proposed; the Board of Trade and Post Office regulations, &c., &c. Also editorial. Ill. 5200 w. Elec Rev, Lond—Sept. 6, 1901. No. 43216 A.

Methods of Safety for the Overhead Electric Trolley System. Edward Manville. Discusses the precautions to be taken to ensure solid construction, and methods of ensuring safety if a breakdown should occur. Ill. and discussion. 5400 w. Elec Engr, Lond—Aug. 30, 1901. No. 43134 A.

Roundhouses.

Locomotive Running Sheds; Eastern Railway of France. An illustrated description of these engine houses and their equipment. 900 w. Engng—Sept. 13, 1901. No. 43343 A.

Russia.

The Connection of the Russian Railway System with the Siberian Railway

(Die Verbindungslinie des Russischen Schienennelzes mit der Sibirischen Eisenbahn). F. Theiss. A description of the Samara-Slatoust railway, connecting the railways of European Russia with Asia. 2000 w. Glaser's Annalen—Sept. 1, 1901. No. 43437 D.

Safety Appliances.

Railway Safety Appliances at the Paris Exposition of 1900 (Die Einrichtungen zur Sicherung des Eisenbahn-Zugverkehres auf der Welbausotellung Paris 1900). G. Rank. A general description of the signalling and other safety appliances exhibited at Paris. Serial. Part I. Zeitschr d Oesterr Ing u Arch Ver—Sept. 13, 1901. No. 43426 B.

Shops.

New Shops at Hannibal, Mo.—Hannibal and St. Joseph Railway. Gives plans, sections and location of machines, with description of the shops and their equipment. 4200 w. R R Gaz—Sept. 13, 1901. No. 43205.

Signalling.

Modern Practice in Railway Signalling. I. A. Timmis. Abstract of a paper read before the Glasgow Congress. Briefly discusses pneumatic and electric systems. 1800 w. Ir & Coal Trds Rev—Sept. 6, 1901. No. 43235 A.

Train Movement Signalling on the Boston Elevated Railway. Howard S. Knowlton. Illustrates and describes the block signal installation, with its interlocking and automatic features. 3300 w. St Ry Jour—Sept. 7, 1901. No. 43164 D.

Steel Ties.

Steel Railroad Ties in Europe. Foster Crowell. A comparison of experimentation in this field in America and Europe. Ill. 4200 w. R R Gaz—Aug. 30, 1901. No. 43016.

Ties.

Study of the Life of Cross-Ties. P. H. Dudley. Illustrated notes dealing principally with the record of 12 years' service of untreated yellow pine cross ties under the traffic of the New York Central & Hudson River Railroad. 5000 w. R R Gaz—Sept. 6, 1901. No. 43155.

Train-Shed.

The Pennsylvania Railroad Train-Shed at Camden. Illustrated detailed description of a rectangular steel structure, accommodating twelve lines of tracks. 1800 w. Eng Rec—Sept. 14, 1901. No. 43267.

TRAFFIC.

Differentials.

Railroad Discrimination Against New York, and the Remedy. Discussion of paper by Abel E. Blackmar. 14800 w Pro Am Soc of Civ Engrs—Aug., 1901. No. 42979 E.

MISCELLANY.

American Railroads.

The Present Position of American Railroads. Thomas F. Woodlock. Extracts from articles written for *The Economist*, (London). 2000 w. R R Gaz—Sept. 27, 1901. No. 43397.

Baggage Handling.

The Mechanical Handling of Baggage (Manutention Mécanique des Bagages). M. Pons. An illustrated description of the conveyors and apparatus for the handling of luggage at the new terminal of the Orleans railway on the Quai d' Orsay, Paris. 6000 w. 2 plates. Rev Gen des Chemins de Fer—July, 1901. No. 43432 H.

Boston Subway.

Boston's New Subway. Willard Winslow. A review of the franchise questions, quoting at length from the Governor's reasons for vetoing the bill. 1800 w. Munic Af—June, 1901. No. 43307 D.

Chicago Franchises.

Street Railways of Chicago. The report of the Civic Federation Committees, including "Analysis of Financial Operations" by Milo Roy Maltbie, and the "Accountant's Report" by Edmund F. Bard. 64000 w. Munic Af—June, 1901. No. 43309 D.

China.

The China Railway Blue Book. Editorial discussion of railway affairs in China, and the attitude of Russia. 3200 w. Engng—Aug. 30, 1901. No. 43143 A.

Indexing.

Indexing Railway Maps and Drawings. R. C. Vial. Describes a system which has proved satisfactory in the drafting-room of the Chicago & Western Indiana R R., based on the decimal system. 5000 w. Eng News—Sept. 5, 1901. No. 43169.

New York Subway.

New York's Subway Policy. William J. Gaynor. A statement of the way the great subway system in New York is being constructed, and a comparison with the scheme proposed for Boston. 2300 w Munic Af—June, 1901. No. 43308 D.

Norway.

Notes on Norwegian Railways. From an article by W. E. Curtis, in the *Chicago Record-Herald*. Information concerning the government railroads in a country where many difficulties must be overcome. 1300 w. Ry & Engng Rev—Aug. 31, 1901. No. 43084.

Railway Development.

English View of American Railway Development. From the London *Saturday* Review. 1200 w. Ry & Engng Rev—Sept. 21, 1901. No. 43366.

EXPLANATORY NOTE.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. Where no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.

Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Científico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest.Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am.Ins.of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Cement.

Directory of American Cement Industries, and Handbook for Cement Users. Edited by Charles Carroll Brown. Size, 6 in. by 9 in.; pp. 645. Price, $5.00. Indianapolis and New York Municipal Engineering Company.

Primarily a directory of makers and users of cement, but preceded by a treatise on the history, manufacture and use of cement with forms of specifications, and data for testing.

Cost Keeping.

Cost Accounts of an Iron Founder. By J. W. Best, F. C. A. Size, demy 8vo.; pp. 110. Price, £0. 2s. 9d. London: Gee & Co., 62 Moorgate st., E. C.

Written from the point of view of the professional accountant rather than the engineer. The most important portion is that dealing with foundry accounts, on which subject there is a dearth of available recorded experience. It is hardly necessary to say that there is no attempt to make use of the card system, but a number of rulings of ledgers, analysis books, time and wages books and similar devices beloved of the professional accountant are given. Foundry managers may, however, glean some ideas from its perusal.

Drawing.

Mechanical Drawing. Written for the use of the naval cadets at the United States Naval Academy. By F. W. Bartlett, Lieutenant Commander, U. S. N. Size, 6 in. by 9 in.; pp. 188; figures, 132. Price, $3.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Designed to suppement the work of the instructor by presenting in available form for study the minor points of method. Based on the best practical methods, but referred particularly to the methods in use in the U. S. Bureau of Steam Engineering. The instruction is at first very full, even elementary, lessening as the student advances and noting only new and important points.

Directory.

Kelley's Directory of Engineers, Iron and Metal Trades and Colliery Proprietors of the United Kingdom. New edition. Pp. 1807. Price, £1 10s. 0d. London: Kelly's Directories, Ltd.

In this, the ninth edition of this well-known and standard work of reference, the Channel Islands (Jersey, Guernsey, etc.,) are for the first time included.

Electromagnets.

Electromagnets. Their Design and Construction. By A. N. Mansfield, S. B. Size, 4 in. by 6 in.; pp. 155. Price, 50 cents. New York: D. Van Nostrand & Co.

The outgrowth of an attempt to rewrite T. H. Du Moncel's "Electromagnets; the Determination of the Elements of their Construction." The present book is a collection of formulæ and data for constructing electromagnets for various purposes, drawn largely from the works of S. P. Thompson, Du Bois, and Jackson. The matter is well condensed and presented. The book forms No. 64 of Van Nostrand's "Science Series."

Gold and Silver.

A History of the Precious Metals. By Alex Del Mar, M. E. Second edition, revised. Size, 6 in. by 9 in.; pp. 477. Price, $3.00. New York: The Cambridge Encyclopedia Co.

This is not a rescension of the first edition (brought out by Geo. Bell & Co., London, 1880), but a new work by the same author. It is a most scholarly work—treating the subject not from a metallurgical standpoint, but in its historical, economic, political and philosophic aspects. An exhaustive review of the production and search for gold and its relations to civilization from the earliest times to the looting of Pekin, with constant attention to the theory of money.

Machine Trade.

A Hand Book for Apprenticed Machinists. Edited by Oscar J. Beale. Size, 4½ in. by 6 in.; pp. 141. Price, 50 cents. Providence, R. I.: The Brown & Sharpe Mfg. Co.

An excellent little book designed to supplement oral teaching in the training of apprentices. It does not attempt to confer skill, but certain matters of knowledge which must accompany manual dexterity in the well-trained mechanic. The book is an outgrowth of the needs of the Brown & Sharpe Company, and is a most interesting development of what is now generally known as "American practice" in the treatment of workshop employees.

Mechanics.

Congrès International de Mécanique, 1900. Three volumes. Size 9 in by 12 in. Vol. I.; pp. 546. Papers presented at the Congress; Vol. II., pp. 94, Report of Transactions at the Meetings, July 19-25, 1900; Vol. III., pp. 300, Written Communications and Reports. Three Volumes complete, 40 francs. Paris: Vve Ch. Dunod.

The complete report of the remarkable congress of mechanical engineering held in the Conservatoire des Arts et Métiers in connection with the Paris exposition. The papers discuss the most important technical problems of the day, including the arrangement of mechanical laboratories, hydraulic motors, internal-combustion motors, steam turbines, automobiles, electric driving, works administration, etc.

Mill Buildings.

Mill Building Construction. By H. G. Tyrrell. Size, 6 in. by 9 in.; pp. 40. Price, $1.00. New York: The Engineering News Publishing Co.

A brief statement of the principles of design and methods of construction which the author has found best for this class of structure. Chapter I deals with loads, Chapter II with general design and plans, Chapter III with materials of construction and structural details.

Navigation.

Tables Condensées pour le Calcul Rapide du Point Observé. Par E. Serres, Lieutenant du Vaisseau. Size 9 in. by 12 in. Price 2 fr. 75 c. Paris: Gauthier-Villars et Fils.

A series of simplified tables for the three fundamental calculations required in navigation: Altitude, latitude, and horary angle. The tables are condensed in such a convenient manner as to enable the highest degree of rapidity to be made in the work of computation, no table occupying more than one or two pages, no auxiliary tables being required except one of the ordinary angular functions.

Price Book.

Architects' and Engineers' Price Book. By T. E. Coleman, F. S. S. Pp. 294. Price, £5 0s. 0d. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain.

This work is intended to afford assistance to those who from time to time must be prepared to determine (often at a moment's notice) the approximate cost of various buildings and works which are in the preliminary stages or for which only general schemes and designs have been prepared. A list showing the actual cost of a few representative buildings and works is added as an appendix.

Smokeless Powder.

Smokeless Powder, Nitro-Cellulose, and Theory of the Cellulose Molecule. By John B. Bernadou, Lieutenant, U. S. N. Size, 5 in. by 7½ in.; pp. 200. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

A collection of translations of important papers by MM. Vieille, Mendeleef, and Bruley, with an account of experiments made by the author and a discussion of the development of smokeless powder condensed from his lecture before the U. S. War College. A valuable contribution to the study of smokeless powders.

Thermodynamics.

Notes on Thermodynamics. By H. W. Spangler. Size, 5 in. by 7½ in.; pp. 69; figures, 24. Price, $1.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The method followed is for the most part the presentation of problems, with explanatory notes and discussions on typical solutions. The author, who is Whitney Professor of Mechanical Engineering in the University of Pennsylvania, presents the volume not as a work of reference but a text book, prepared after consultation of all the later writers, in which use has been made of whatever seems the most satisfactory method with a view of covering the theoretical side of thermodynamics more rapidly than was possible with the aid of pre-existing books.

Trade Marks.

Trade Marks. By Ernest Salaman. Pp. 16. Price, one shilling. London: Mercantile Publishing Syndicate, Ltd., 30 Walbrook, E. C.

A pamphlet dealing with the English law of trade marks, particularly reviewing the cases of "Camel Hair Belting," "Cellular Clothing," "Dolly Blue," and "Solio" photographic paper, with interesting comments on these recent decisions and the practice of the Patent Office as regards registration of "invented" words.

Works Management.

The Management of Engineering Workshops. By A. H. Barker. Size, 8vo. Price, £3 3s. 0d. London: Institution of Junior Engineers.

The substance of a series of lectures before the Institution of Junior Engineers, with the resulting discussions, is given in this excellent and practical work. While not necessarily agreeing with all the views of the author or his critics, we have no hesitation in saying that the volume should be read by all engineers interested in the adoption of modern methods of organization and management. It is full of practical matter that can hardly fail of being turned to account.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

Vol. XXII. DECEMBER, 1901. No. 3.

THE GROWTH OF AMERICAN COAL EXPORTS.

By Frederick Edward Saward.

On October, 1900, Mr. Saward's widely quoted article on "The World's Need of Coal and the United States' Supplies" was published in this Magazine. Probably there has never been a period of equal length so tensely filled with industrial interest as the fourteen months intervening. The attention of the manufacturing world has been centred upon the manifest tendency to a shifting of the seat of supremacy in the steel trade. But already it is beginning to be clear that any system which will strongly handle and control the steel output, so as to avoid the depletion of the iron reserve, (which depletion Mr. Hull ably showed in our issue for August, 1900, is intimately connected with industrial depressions) is widely beneficial to the whole world. Back of the steel industry, even more elementally important to material progress, lies the fuel industry. If the United States can serve as a storage battery of this fundamental form of power, able to correct the serious and crippling fluctuations caused by overload on Europe's long-depended-upon stores, the ultimate result will be a highly profitable stability for manufacturers everywhere. It is in this light that a new and thoroughly contemporaneous review of American coal-export possibilities is of very great importance.—The Editors.

IMPORTANT and highly significant developments in the American coal trade have recently been attracting world-wide attention. Not only have the great coal-producing and coal-carrying railroads of the eastern States been brought together, and, by the "community of ownership" plan, placed under the control of powerful financial interests, but a variety of factors in combination have brought the possibility for a large increase in the export of the bituminous product. Within the most recent period America has been shipping anthracite to Europe, also. As the exporting of coal increases it will add millions yearly to the annual income of the country. That American coal is destined to compete with the coals of England and Wales in the markets of the world is unquestioned, and the bituminous or soft coal produced in Pennsylvania, West Virginia, and Alabama is already finding markets abroad. Pennsylvania produces for the seaboard trade what is known as Clearfield coal, originating mostly on the line of the Pennsylvania Railroad, but also reaching market over the Philadelphia and Reading Railway; then there is the coal on the Alleghenies, and to the westward is the Pittsburg district; some coal from the eastern portion of this district reaches tidewater by rail over the Pennsylvania. Pittsburg coal has also a large market at New Orleans, some 1,700,000 tons being sent there during certain portions of the year when water transportation to the port of New Orleans can be had via the Ohio and Mississippi rivers. The disposition on the part of steamship owners to coal up in American ports, owing to the prices being less than those ruling elsewhere, has led to a large increase in the business at this port, and an extensive "bunkering" trade is done in Pittsburg coal at New Orleans, based on a rate of but $3.60 per ton f. o. b.

The steam vessels carrying mules, forage, etc., for the British government to South America, took on very liberal supplies of coal at this port; Alabama coal is also had there for steamship use, coming to the Mississippi at Greenville, and being there transferred by barge to New Orleans and selling at the same price as the Pittsburg coal. With the improvement of the Warrior river by slack-watering, now under way, there will be a supply of Alabama coal for steamship use at Mobile, or at New Orleans, at a considerably less figure. The introduction of oil as fuel on the Gulf ports has as yet made no inroads on the coal trade. At Pensacola, there has been loaded a very considerable tonnage of Alabama coal for export to the Mexican railway systems, and this trade would seem to belong naturally to the coal producers of Alabama.

A TRAIN OF 50-TON COAL CARS ON THE BALTIMORE & OHIO RAILROAD.
Illustrating one of the important factors in the cheap transport of American coal.

The famous Cumberland coal is a decidedly soft coal, breaking into small pieces rather than crumbling, and this would not be in favor with foreign consumers, notwithstanding its richness in fuel properties, as that trade demands a lumpy coal; at the same time this coal is a favorite for bunker or steamship use on the trip across the ocean from Baltimore, and the Fairmont coal of West Virginia is largely shipped in cargo lots abroad. There has been within the past year a considerable tonnage of Cumberland coal, in cargo lots, for the use of the United States Navy, sent to the Philippines, to Yokohama, and to the new coaling station at Pichilique bay on the Pacific, so that the United States Navy now uses the product of American mines, instead of being compelled to buy and use foreign coal, upon foreign or colonial stations.

The coal received from the American coal mines comes in railway cars of forty to fifty tons capacity, which run on to a high trestle, and the largest vessels are speedily loaded with coal at any condition of the tide, with very little labor and with a minimum amount of breakage. Such loading ports are Lambert's Point, Norfolk Harbor, where the Norfolk and Western Railroad has two large piers, with between twenty-five and twenty-eight feet of water at low tide,

CHESAPEAKE AND OHIO RAILWAY'S COAL-LOADING PIERS AT NEWPORT NEWS, SHOWING THE EXTENT OF THE TERMINAL FACILITIES AND EQUIPMENT.

and where coal from the Pocahontas region of West Virginia is loaded for all points of the world. I am informed that more than 300,000 tons of bunker coal were loaded there last year, and that will be doubled in 1901. Across Hampton Roads, where the depth of water reaches sixty-five feet at the end of the coal wharves, the tidewater terminus of the Chesapeake and Ohio Railway has two wharves of very large capacity, and there tonnage has been loaded for many foreign ports, such as Montevideo, Uruguay; Marseilles, France; Piræus, Greece; Algiers, Africa; Vera Cruz, Mexico; Trieste, Austria; Antwerp, Belgium; Kingston, Jamaica; Hamburg, Germany. The terminus of the Pennsylvania line at Canton, Baltimore, affords opportunity for Clearfield coal for bunker purposes to a very great extent, while the Baltimore and Ohio has the very large coal pier at Curtis Bay, especially for the export trade, and here the very valuable coal (from an export point of view) mined in the Clarksburg and Fairmount regions of West Virginia, on the line of the Baltimore and Ohio, is transferred from car to vessel. The erection of this pier is a significant recognition of the present state of affairs, and dating from October 15, 1901, all the export business goes over this pier. Philadelphia has not been behind hand in the export business, and there are two important coal-shipping points—Greenwich, the terminus of the Pennsylvania Railroad, and Port Richmond, where the Philadelphia and

Reading Railroad coal is transferred. Bunker coal alone in Philadelphia is said to amount to 500,000 tons annually. Some recent foreign shipments were to France, Germany, Italy, Scotland, Newfoundland, Mexico, British West Indies, Cuba, Danish West Indies, Haiti, Santo Domingo, and Brazil; at the rate of say 750,000 tons a year.

At New York the soft-coal-shipping wharves are:—South Amboy, of the Pennsylvania Railroad; Perth Amboy, Lehigh Valley property; Port Reading, owned by the Philadelphia and Reading; St. George, Staten Island, owned by the Baltimore and Ohio; Port Liberty, Jersey City, used for shipping Beech Creek coal, and Harsimus piers, Jersey City, owned by the Pennsylvania Railroad. From these New York piers there has always been a very large business done in supplying bunker coal to foreign-going steamers, the coal being brought in barges to the vessels, and it is fully equal to 2,500,000 tons a year; the export trade in cargo lots is either done direct at the wharves referred to or delivered from barges alongside the vessels.

Waterways are not to be ignored, even in a country of vast railroad systems. The tonnage of the Monongahela River is now seven-ninths of that of the Suez Canal, and with the development of the new coal fields of the upper pools the United States engineer in charge of the improvements on the river is certain that in a few years the tonnage will equal that of the great eastern waterway. He is also positive that the Government, after having expended over $4,500,000 to establish a free slack-water system, will endeavor to afford every facility possible for the transportation of coal, and as soon as the tonnage warrants increasing the size of the upper dams it will be done.

For the fiscal year ending June 30, 1901, 6,000,000 tons of coal passed through the locks of the Monongahela river, and of this amount 2,500,000 tons were used in the Pittsburg markets. In addition to the coal there is a vast tonnage of general merchandise, and the operators of the upper pools say the traffic is enough to warrant immediate action by the Government in the matter of increasing the size of the upper locks. While the initial fight is being made on dam No. 6, it is understood that the operators intend formulating plans for an improvement of the entire upper streams in order that the new coal field can be given every facility for shipping its product.

For the improvement of dam No. 6, $18,500 has just been appropriated and the single lock lengthened so that a tow 190 feet in length can be passed through at once. Major Powell favors double locks where the traffic demands it. In his recommendation for the new lock at dam No. 5, $480,000 was asked, and of this amount $295,000 was to be expended on the lock alone. For a new lock at No. 6 the cost would probably amount to more.

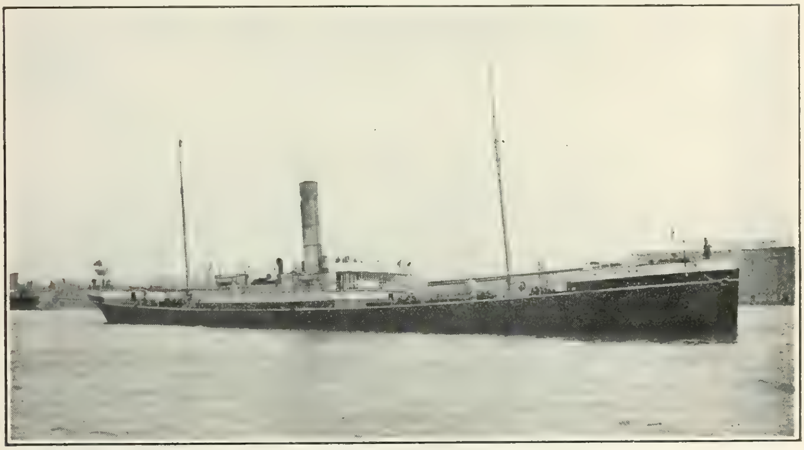
Another of the waterways of the United States which has been improved at the expense of the Government is the Great Kanawha. The river is navigable by means of locks and dams, of which there are ten; eight of these are "moveable" dams, being so constructed that they can be put up and down. These dams are kept up when it is necessary to do so to make coal-boat depth (6½ feet), and down when there is water enough running in the river to make this depth without the dams; by putting up the dams a slack-water canal is formed, thus directing all navigation to the locks. At such times as the locks are not used their uprights are thrown to the bottom of the river and the moveable parts housed at the river side until low water comes again, thus affording unobstructed navigation. The fall in this river is said to be ordinarily about one foot to the mile; the distance from mouth to head of navigable water is about 72 miles; the dams begin at No. 2 and number down stream to 11, inclusive, the levels varying in length from 17 miles, in lock 11, to 5 or 6; a fair average, however, would be about 7 miles. The two upper dams (Nos. 2 and 3) are of the ordinary fixed type, like those on the Monongahela River. The locks are of sufficient length and breadth to admit four barges, two abreast, and thus the fleets are locked through.

To show the increase of coal traffic on this waterway one may go back to 1875 and note the comparative tonnage since that time up to and including 1900, viz:—

	Bushels.	Tons.
1875	4,048,300	161,932
1885	17,812,323	712,493
1890	24,161,554	966,462
1895	21,982,600	879,304
1900	30,837,000	1,233,480

On the Big Sandy river in West Virginia, the Government has begun the slack-watering after the manner of the Kanawha. One dam has been completed, and there will be twenty-one others before the river and the Louisa and Tug Fork branches thereof are ready in full for navigation. The Big Sandy forks at 28 miles from the Ohio into the two streams named; one is to be made navigable for 71 miles and the other for 80 miles. This will open up an immense territory embracing hundreds of thousands of acres of coal and timber lands—enough coal to supply the northwestern States for 200 years is a modest estimate. The Norfolk & Western Railroad draws a little coal out of the eastern end of the country drained by the streams named, but there is acreage along their course which can be profitably worked only by having water connections, owing to the peculiarly rough country.

Within the past few weeks there seems to have been a better opportunity for sending out coal from the United States—both anthracite and bituminous—owing to the reduced rates at which vessels could be had for its transportation. On the 5th October, the first full cargo of anthracite ever shipped to Germany was sent in the British steamer Ormesby from Port Richmond, Philadelphia. The cargo consisted of about 3,734 tons of mixed stove and nut, the proportion of the latter size being one-third. It was mined and shipped by the Philadelphia and Reading Coal and Iron Company, and since then other cargoes have followed, making a total business to the port of Stettin, Germany, of 11,000 tons for the past month. The opportunity came when the vessel could be secured at a 10s. 6d. ($2.60) freight. Equal to 18s. ($4.50) was paid for the coal, and the cargo will thus stand in 28s. 6d. at Stettin. As Welsh anthracite is 27s. f. o. b. Swansea, and the freight is 5s., this would make the c. i. f. price at Stettin 32s., or 3s. 6d., equal to 87 cents, more than that of American coal under the present low freight rate from the States. In addition to this tonnage, a very large business is likely to be done with Berlin, via Hamburg, as a prominent merchant of that city has recently decided to visit the United States looking to the development of a trade in anthracite for the city named; he has had offers of vessel freights from New York to Hamburg at 7s., or $1.75 per ton, and



A CARGO OF AMERICAN COAL LEAVING BALTIMORE IN THE BRITISH STEAMSHIP WESTMINSTER.

5,256 gross tons, shipped May 9, 1899, for Dewey's fleet at Manila. The largest cargo loaded out from Baltimore.

NATURAL AND MECHANICAL ADVANTAGES OF COAL MINING IN THE UNITED STATES.
Electric locomotive drawing loaded cars from a horizontal entry.

on this basis could do a business of something like 200,000 tons annually. The preference with the European shipper or handler of anthracite seems to be for lump coal—to be broken down to size on arrival. Anthracite has also been sent from America to Bordeaux.

The importance of the recent shipments of anthracite from the United States to Bordeaux, Hamburg and Rotterdam can be easily appreciated. Not alone is this a *bona fide* attempt to introduce American anthracite into the German market as a substitute for the Welsh coal of the same character, but it is being effected through the medium of the established lines trading between Philadelphia and these ports. If a rate of freight is obtainable which will admit of these consignments, it is fair to assume that future business can be made on the same basis, and thus a regular trade with Germany opened up. The outcome of this new German business will be awaited with interest. One of the largest merchants in Berlin, says, in regard to these shipments: "Heretofore no American anthracite has ever come to Germany, but we think that we should be able to begin with about 100,000 to 200,000 tons a year, as the anthracite consumption is growing with us every year. There is none in our country, and England offers so short a supply and at such high prices that our big consumers are really anxious to draw at least a part of their supply from the United States." The possibilities of the future will be in the creation of an American collier's fleet, just as much as the English collier's fleet means the force of the British coal-export trade.

Shipments of anthracite from the United States have heretofore been to Canada and Nova Scotia mainly, with a few small lots to Cuba, but the exports of bituminous are growing every week of late, as low freight rates can be had to the continent and to other places formerly supplied from British ports; and of so wide a character is this trade that on the same day shipments are noted from Atlantic coast loading ports to the Mediterranean and to San Francisco. Tonnage has been done to Genoa, Marseilles, Piræus, Algiers, St. Nazaire. Trinidad, Stettin, Colon, Trieste, Antwerp, Hamburg, Tampico, Coronel, St. Pierre, Rio Janeiro, Montevideo, Vera Cruz, Kingston, and Manila. The latest rates of freight are quoted herewith:—$1.40 to $1.45 to Havana or Matanzas; $1.50 to $1.55 to Cienfuegos; $2.00 to Cardenas or Sagua; $1.75 to St. Lucia or St. Thomas; $1.60 to $1.70 to Kingston; $1.70 to $1.75 to Port Spain, Trinidad; $1.85 to Bermuda; $2.25 to Demerara; $1.50 to $1.60 to Tampico or Vera Cruz; 14s. to 14s. 3d. to Rio; 9s. 3d. to 9s. 5d. to a direct port in the Medi-

A FACTOR OF CHEAP COAL MINING IN THE UNITED STATES. PICK MINING IN A VEIN OF SOFT COAL 10 FEET THICK.

terranean; 8s. 6d. to 9s. to Bordeaux, St. Nazaire or Havre; $5.75 to $6.00 to Manila, Yokohama, or Nagasaki. One of the latest tests of American soft coal was on the French cruiser D'Estrées, which escorted the Duke and Duchess of York from Halifax to Quebec and put in at New York port to fill her bunkers; the engineer's report to his Government will develop orders to fill up the bunkers of French warships in North Atlantic waters with American fuel. Nova Scotia is also looking to a development of a foreign trade, and the Dominion Coal Company has an agent abroad for that purpose.

The United States output of coal now exceeds that of Great Britain, which country up to two years ago was the largest producer in the world, and the total of all grades will be 275,000,000 net tons this year. The whole trend of public discussion in England is of the conservation of her coal supplies, and at the Glasgow meeting of the British Institution of Mining Engineers, Sir William Thomas Lewis, president thereof, in his address, said: "With reference to the number of tons of coal unworked in our different coal fields, it is, of course, easy to calculate from the plans and sections of the seams proved, making the usual allowances for faults and loss in working; but the important question is, how many of the seams can be assumed to be workable to a profit from time to time, and how much of the coal contained in the various seams can be usefully obtained? If the thin seams cannot now be worked, while we have superior coals in thick seams to mix with them, I fear that many of the thinner and the inferior coals are much less likely to be profitably worked in the future." The industrial supremacy of the United States is being increased in many of the products of mine, forest, and workshop, and in none more earnestly than in the matter of coal; this will no doubt be handled in many of the foreign ports by English houses, already established for so many years and having all the facilities for doing business in the Continental and other ports, and this will give the opportunity for the conservation of British coal, which is produced at greater cost than American because of the depths to which it is now necessary to extend the workings and the greater cost of labor per ton, there being little other than manual labor employed in the extraction of the coal at British pits. On the contrary, a large tonnage in the United States is mined by machinery; the great increase in machine-mined product in the United States—i. e., 168 per cent. in the last five years—is the best evidence obtainable of the economic advantages thereby secured in raising coal, and there is no doubt that British collieries would derive great benefit by following the American example in the more general

A DRIFT MINE IN THE SOFT-COAL REGION OF THE EASTERN UNITED STATES.

The natural advantages are apparent. No pit mining, shaft sinking, raising, or pumping is necessary. The entry takes a double line of standard-gauge railway; the water flows away by gravity.

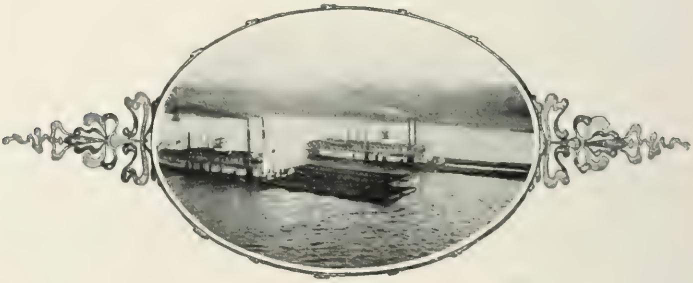
adoption of coal-getting by electric- or by compressed-air-driven machines. The number of mechanical coal-cutters employed in the United Kingdom during 1900 was only 311, of which 240 were driven by compressed air and 71 by electricity, the quantity of coal so obtained amounting only to 3,312,000 tons; while in the bituminous-coal districts of the United States there were 3,125 mechanical cutters used at collieries employing above 100,000 persons, which yielded an output of about 45,000,000 gross tons. It is this cutting by machinery that enables the American producer to put his coal on cars in Pennsylvania at 95 cents a ton, and in West Virginia at 80 cents a ton.

A year ago, when the possibility of the exploitation of an American export trade was spoken of, the rate of ocean freight was decidedly against the doing of any extended business—being quoted at 20s. to the Mediterranean—although the ruling American prices of $2.50 to $3.00 per ton f. o. b. were half what was being asked at the Welsh loading ports; at the latest advices, best Welsh coal was quoted at $4.32 to $4.56 per ton, while freights to Marseilles are put at $1.25, to Genoa $1.32 to Rio $3.12. A new feature in this connection is the report that a line of colliers will probably be established to ply between Newport News and Marseilles. Up to date there seems to be almost an over-supply of foreign vessels willing to engage in the coal trade from the western side of the Atlantic.

The striking feature of this development is the evidence it seems to afford that the ability of the workers in the United States is greater, and the product per man and machine in excess of anything abroad; the output per employee, in soft-coal mining, was 579 tons in 1900, while the product of each mining machine in use is put at 13,000 tons for the same year. There have been many causes for this, but none equal to the intelligent labor coupled with the disposition to make use of the most advanced appliances in every line.

The export of coal from the United States would appear larger, if the coal put on steamers for bunker use was included. In Great Britain and in France all coal for the use of steamers engaged in the foreign trade is included in the exports in the official returns, although separated as to items and quantities, while coal for the use of steamers engaged in the home or coasting trade is excluded. The principle in Germany is to exclude all coal put on board vessels to be used as bunker coal from the import and export accounts. In Great Britain, the coal shipped for the use of steamers in the foreign trade amounted in 1899 to 12,226,801 tons, and in 1900 to 11,752,316 tons.

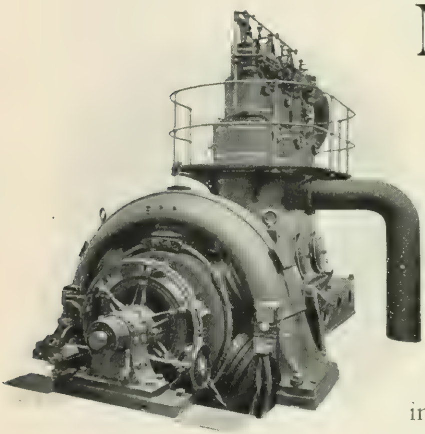
It is futile for American coal producers to think that "anything will do for the foreigner"; care should be taken to gain a good impression in the shipment of coal, if a success is looked for. United States exporters should devote their efforts to shipping first-class mineral, in lumps and duly screened, so as to compete successfully with the English product. As a rule, people on the continent of Europe will be adverse to a change, unless they actually find it is to their great advantage both for quality and price.



ENGLISH, AMERICAN, AND CONTINENTAL STEAM ENGINEERING.

By Philip Dawson.

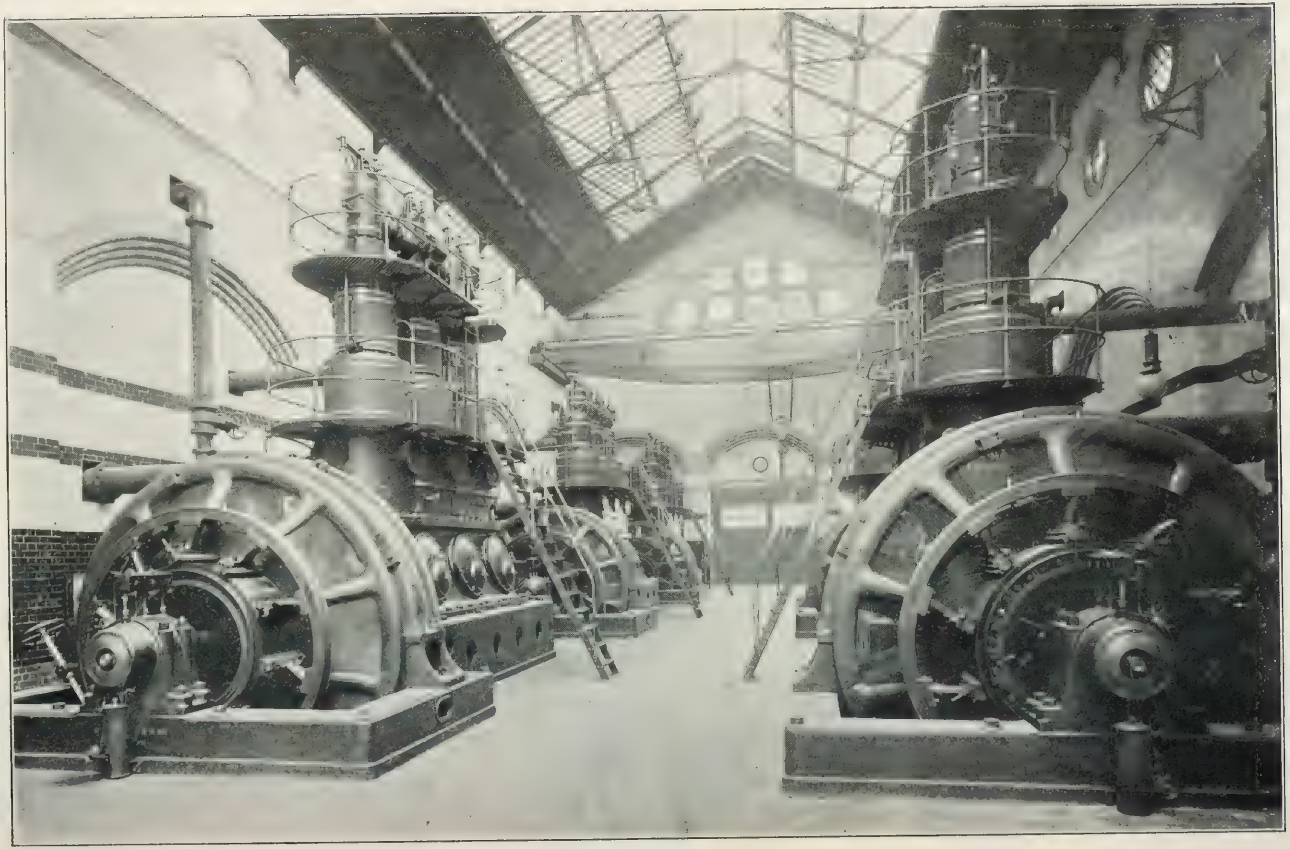
Mr. Dawson's first article appeared in THE ENGINEERING MAGAZINE for November last. The article in this issue will be followed by a discussion of American practice, and a concluding paper will treat of steam engineering on the Continent of Europe.—THE EDITORS.



MY preceding paper dealt generally with the leading characteristics of British, Continental, and American steam engineers and their work, and with British steam-engine practice in particular as displayed by the construction of some of the leading engine-building firms. I may now present the subject from an even more comprehensive point of view by brief description of a few of the most important British electric-lighting and traction plants using high-speed engines.

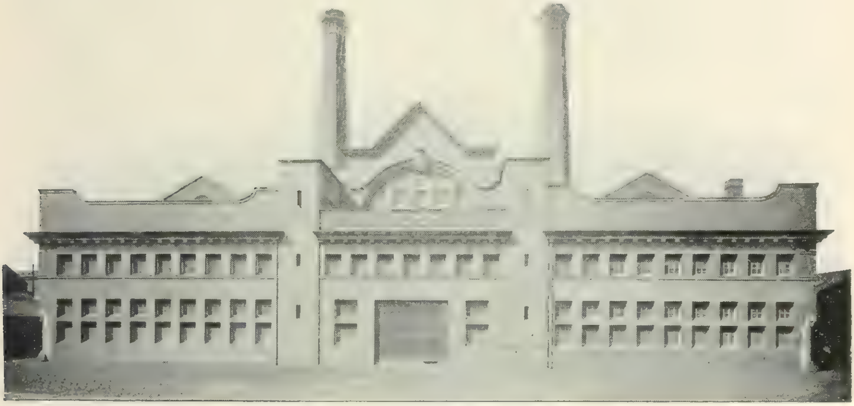
Pumpfields Station, Liverpool. The engine room is 247 feet long, 52 feet wide, and 37 feet high to the eaves of the roof. The boiler house is in two parts, one part on each side of the engine room, each 51 feet wide, 247 feet long, and 26 feet high to the eaves. The engine-room floor is composed of steel joists and concrete. Each boiler house is furnished with a brick chimney stack 220 feet high, having an internal diameter of 12 feet 9 inches at the top. A coal conveyor supplies the boilers with coal. The boilers are of the Lancashire type, 30 feet long and 8 feet in diameter, with flues 38 inches in diameter. There are fourteen in each boiler house, making twenty-eight in all. Mechanical stokers of the Vicars or Hodgkinson pattern are employed.

The engines are of Willans vertical type, nine-cylinder triple-expansion compound, running at 230 revolutions per minute and giving a continuous output of 1,200 indicated horse power, or 1,500 for short periods. There are three cranks set at 120 degrees, and the crank shaft is 11 inches in diameter. The cylinders measure 15 inches



GENERAL VIEW OF WILLANS ENGINES IN THE LIVERPOOL CORPORATION STATION ; EACH TRACTION SET IS OF 1,200 HORSE POWER.

20½ inches, and 34⅝ inches, by 16⅞ inches stroke. The governor is of the high-speed type with speed-regulating adjustment, and automatic expansion gear is provided. The crank chamber is completely enclosed, and the lubrication of all the working parts is by splash, no lubricators or oil pumps being required. The bearings are lined with white metal. There are twelve engines in all.



PUMPFIELDS STATION, LIVERPOOL.

The engines are direct-coupled to Siemens multipolar shunt-wound self-excited dynamos, which give 1,420 amperes at 550 volts. Each machine is mounted upon a bed plate which is rigidly connected to the engine bed plate. The armature shaft is carried at one end by a flanged connection to the crank shaft, and at the other end by a massive bearing attached to the bed plate. The armature serves instead of a flywheel for the engine.

Hull Electric Tramways. The electric tramways at Hull furnish another example of high-speed direct-coupled units being employed for traction work. The steam-generating plant consists of four Lancashire boilers, 30 feet long and 8 feet diameter, fired by Vicars mechanical stokers; the working pressure is 150 pounds per square inch. A Green's economiser having a heat surface of 2,618 square feet is also installed. The engine room measures 83 feet by 44 feet, and contains three Bellis engines each direct-coupled to a Siemens bipolar dynamo. The engines are of the ordinary vertical enclosed double-acting type, with automatic forced lubrication; they are designed to develop 470 indicated horse power at normal load with steam at 140 pounds per square inch, when running condensing at 360 revolutions per minute; 700 indicated horse power can however be obtained for short periods.

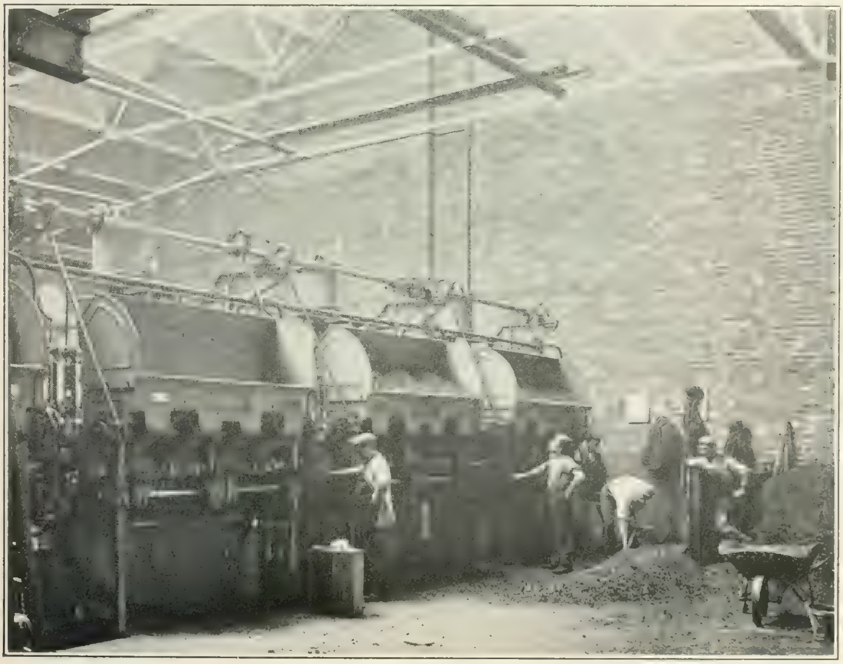
LANCASHIRE BOILERS AND MECHANICAL STOKERS, PUMPFIELDS STATION, LIVERPOOL.

The engine really consists of three compound tandem engines, working onto one shaft, the three cranks being at 120 degrees with one another. The speed is governed by a shaft governor which actuates a throttle valve. Each of the dynamos is designed for an output of 550 amperes at 500-550 volts. The armature is not bolted direct to the flywheel, and there is a bearing between the two, on account of the great weight of the flywheel.

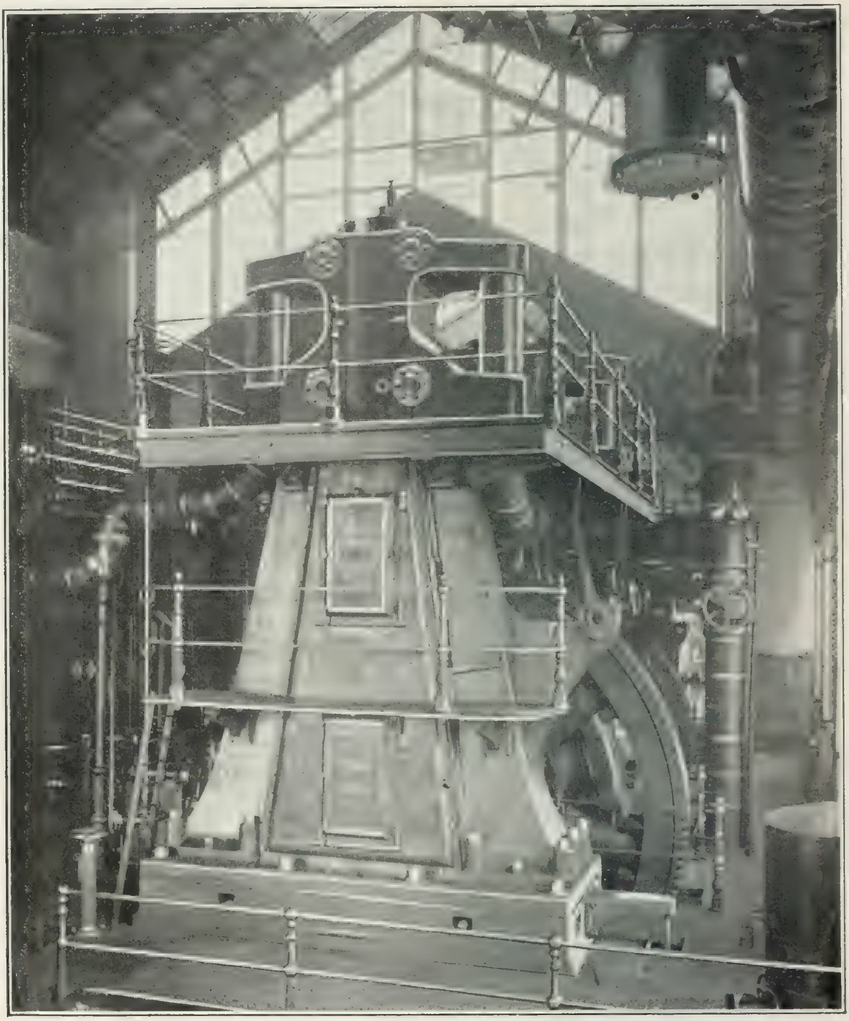
This is a typical British type of station, the high-speed engines, two-pole dynamos, and Lancashire boilers all being used. Two-pole machines are, however, dying out at last, and their place is being taken by multipolar machines, which are becoming standard practice.

The Ferranti steam engines are generally of the vertical cross-compound enclosed type, and run at or near 250 revolutions per minute. Both cylinders, including the covers, are steam-jacketed. Balanced slide valves actuated by link motion are employed for the steam distribution; on the high-pressure side this gives automatic control, while the cut-off on the low-pressure is adjusted by hand. The speed is governed by a high-speed spring-loaded governor. The crank-shaft bearings, of which there are two, are of the spherical type. There is no special flywheel, as the rotating part of the alternator serves instead, being mounted on the shaft between the high- and low-pressure cylinders.

It is practically only quite recently that slow-speed direct-coupled sets have been used in Great Britain, and in this respect the country is behind the Continent and United States; doubtless the backwardness of electric traction is responsible for this. There are in the United Kingdom well-known slow-speed-engine makers, such as Yates & Thom, Musgraves, Hick Hargreaves, Galloways, Robeys, Barber & Combe, Adamsons, etc., but most probably it was the advent of the American Reynolds-Corliss engine, more than anything else, which caused the awakening of the manufacturers to the large field open before them and to the necessity of building a slow-speed engine which would answer the requirements of electric-traction engineers. The conditions under which engines for electric traction have to run are very trying and differ in many ways from those which have to be

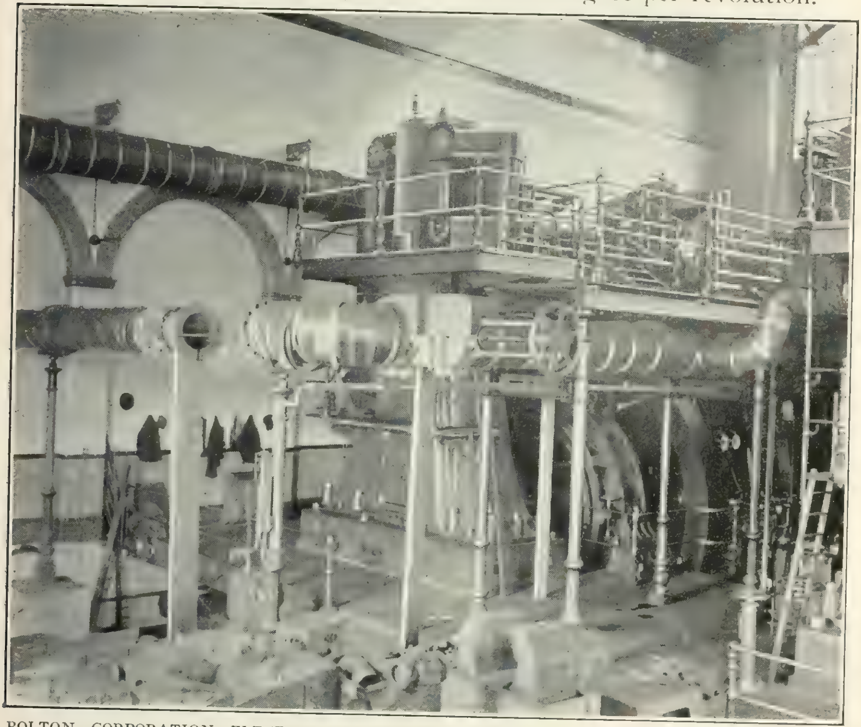


LANCASHIRE BOILERS AND VICARS MECHANICAL STOKERS, HULL CORPORATION TRAMWAYS.



MUSGRAVE ENGINES AT BOLTON CORPORATION ELECTRICITY WORKS.
Cylinders 24 and 45 inches by 42 inches stroke; 100 revolutions per minute.

considered in the case of electric lighting. The load is constantly varying and the variations are large and sudden. Breakdowns are more serious than in a lighting station, so large factors of safety are necessary, and in many cases the station must be in continual operation for several consecutive days. The conditions under which a traction engine works are, if anything, more onerous than those of a rolling-mill engine; a slight variation either in the number of revolutions per minute or in the angular velocity during one revolution is very serious in a traction-station engine, whereas it is of no consequence in a rolling mill. Constancy of speed is of especial importance where polyphase currents are used, and under no circumstances should the angular velocity during one revolution vary more than three quarters of one per cent., or 1/30 of one natural degree per revolution.

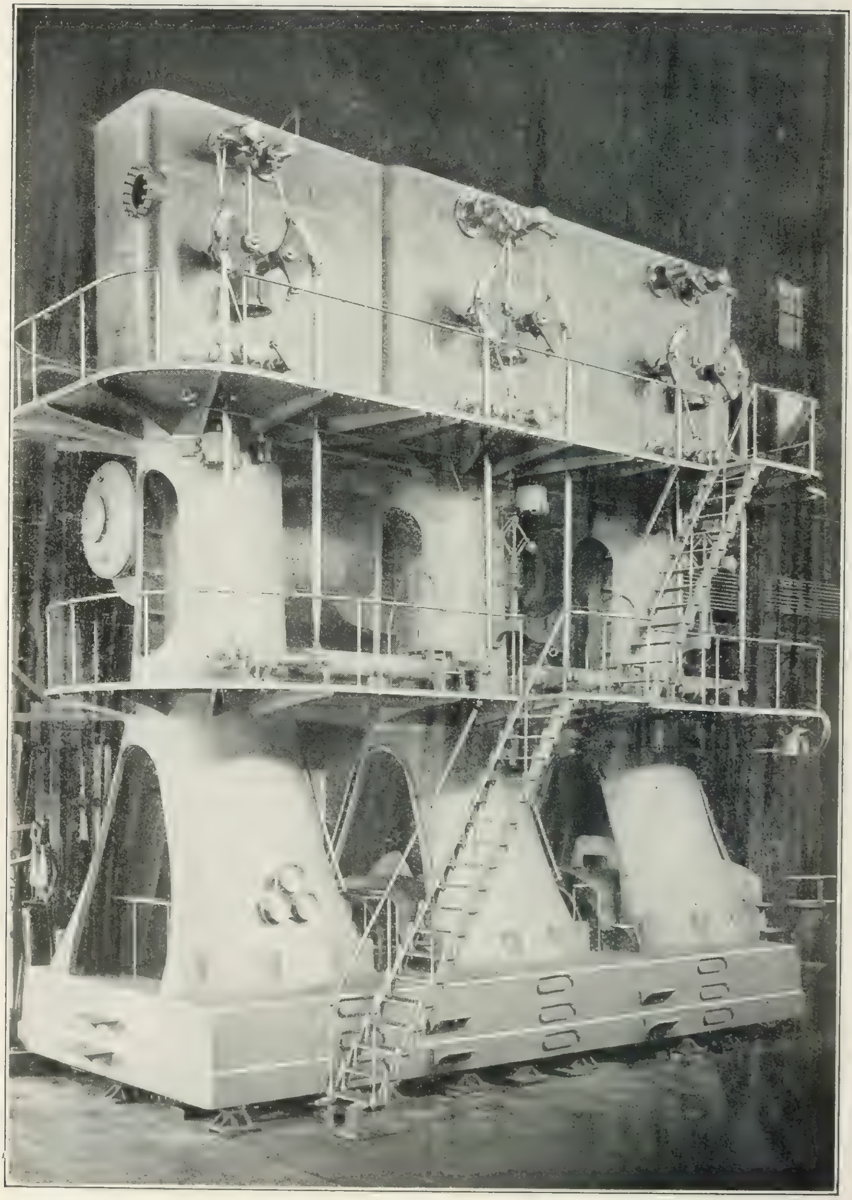


BOLTON CORPORATION ELECTRICITY WORKS. MUSGRAVE ENGINES OF 1,000 HORSE POWER.

Cylinders 24 and 45 inches by 42 inches stroke; 100 revolutions per minute.

It may be of interest to describe briefly one or two stations containing slow-speed engines built by British firms.

Bolton Corporation Electricity Works. Steam is supplied by nine Lancashire boilers through a system of steam piping which consists of two ring mains. The engines, which were supplied by Messrs. Musgrave & Sons, are of the vertical cross-compound condensing type, fitted with Corliss valve gear, and run at 100 revolutions per minute. There are two units, each 1,000 indicated horse power, but capable of giving 1,350 horse power, and two 500-horse-power units, which can work up to 650 horse power. The generators and flywheels are placed between the high- and low-pressure cylinders. The following are some of the dimensions of the 1,000-horse-power engines:—



ALLIS ENGINES FOR THE GLASGOW CORPORATION TRAMWAYS.

As erected in the works before shipment, without the shaft, flywheel, or outboard bearing.

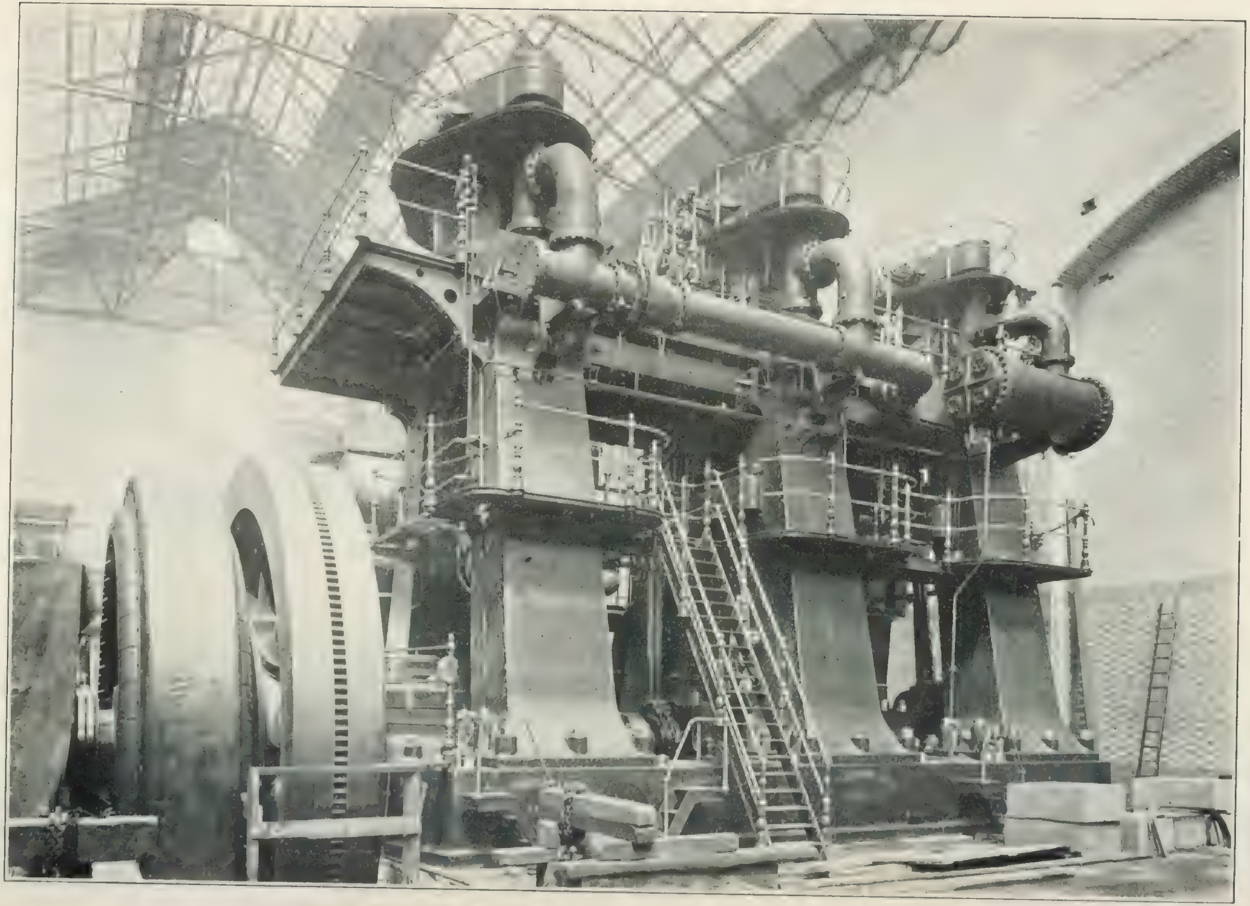
Cylinders, 24 inches and 45 inches, by 42 inches stroke; high-pressure piston rod 5 inches diameter, low-pressure 5¼ inches diameter, connecting rods, made of iron, 8 feet 9 inches long, 5¼ inches diameter at crosshead end and 7½ inches diamter at crank end; crank shaft, made of Siemens steel, 14½ inches diameter and 29 inches long in the neck, 15½ inches diameter in the body, and 19 inches diameter at the wheel boss; flywheel 18 feet diameter and weighs 40 tons of 2,240 pounds, built up of eight rims, segments, and arms, held together by cotters and bolts.

The governor is driven by ropes from the main shaft and acts directly on the Corliss trip gear. The crank chamber is entirely enclosed. Lubrication is effected at a pressure of about 10 pounds by a small pump worked by a link from the exhaust-valve eccentric rod. The engines are guaranteed to maintain constant speed within 2½ per cent. either way from the normal between full load and no load.

Glasgow Corporation Tramways. In the case of the Glasgow Tramways there will be furnished ample data for comparing English and American Corliss engines, built to the same specification. In this instance there are two engines by Musgrave & Sons and two by the Edward P. Allis Company, supplied by Messrs. Robert W. Blackwell & Co., Ltd., of London, both built to Mr. H. F. Parshall's specification; both pairs are of the three-cylinder vertical compound type, each engine indicating 4,000 horse power at normal load, when running at 75 revolutions per minute.

The Allis engines are of the well-known Reynolds-Corliss type, and the following dimensions will give some idea of the size:—

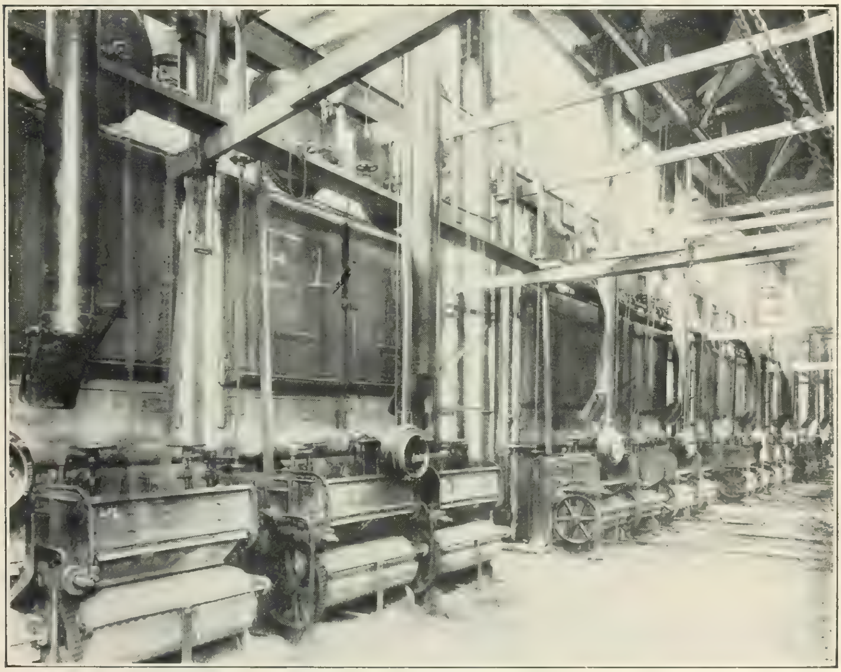
The cylinders measure 42 inches, 62 inches, and 62 inches diameter by 60 inches stroke. The first and second journals measure 22 inches by 36 inches, the third and fourth 24 inches by 36 inches, the fifth 32 inches by 64 inches, and the outer bearing 30 inches by 48 inches. The diameter of the shaft through the fly-wheel and generator is 36 inches. The dimensions of the crank pins are:—High-pressure, 12 inches by 12 inches; first low-pressure, 16 inches by 12 inches; second low-pressure, 20 inches by 12 inches. All three piston rods are the same size, viz., 8 inches diameter. The cylinders are furnished with Reynolds-Corliss automatic double-ported valve gear, each with two eccentrics, the valves being in the cylinder heads. The speed is controlled by a special weighted type governor which acts upon both high-pressure and low-pressure cylinder gears. Attached to each steam-valve wrist-plate there is a disconnecting device, which enables the valve gear of any cylinder to be worked by hand. The ec-



MUSGRAVE ENGINES IN THE POWER PLANT OF THE GLASGOW TRAMWAYS.

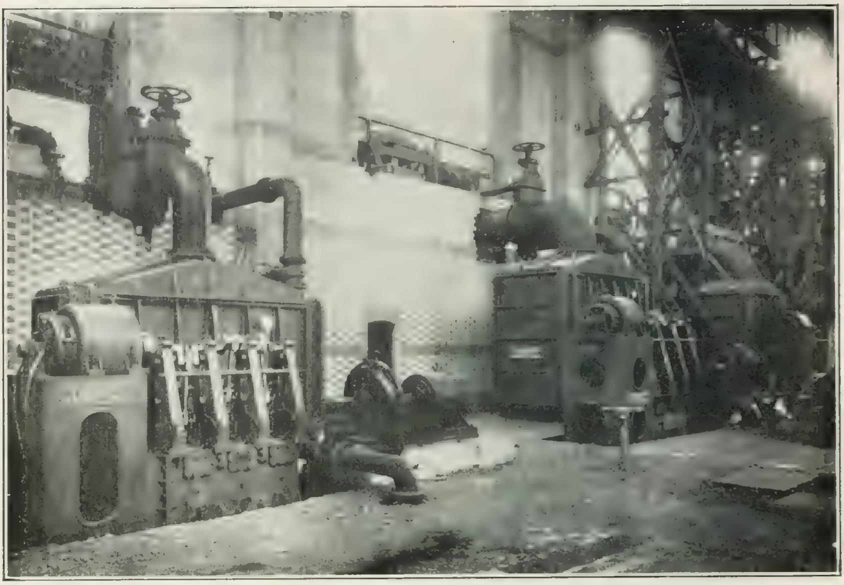
Cylinders 42, 60, and 60 inches by 60 inches stroke; 75 revolutions per minute, steam at 140 lb. pressure; normal indicated horse power 4,000, maximum 5,000. British Thomson-Houston three-phase alternator, 2,500 kilowatts, 6,500 volts, 25 cycles.

centric straps are lined with babbitt, bored and scraped to fit the sheaves. The eccentric sheaves are secured to the shaft by means of adjustable keys to allow for correct adjustment of position. The rocker-arm pin is so fitted as to be capable of easy removal. The cross-heads are fitted with babbitt-faced removable and adjustable shoes, turned and scraped to fit the bored sides of the vertical frames. The cranks are of the fan-tail pattern and are set at an angle of 120 degrees. The shells of the main journal bearings are of cast iron and are water-jacketted. They are lined with babbitt metal, expanded in place and bored and scraped to fit the shaft, with suitable oil channels to effect an even distribution of oil. There is one top and one bottom shell, with a spherical seating; the lower shell can be removed by jacking up the shaft half-an-inch. The steam consumption is guaranteed not to exceed 14 pounds per brake horse power when indicating 4,000 horse power under normal conditions.



BABCOCK AND WILCOX BOILERS WITH CHAIN-GRATE STOKERS, PINKSTON POWER STATION, GLASGOW.

The description given above of the Allis engines would, in the main, be equally applicable to the engines made by John Musgrave and Sons, but one or two dimensions are a little different. In this engine, the high-pressure, first low-pressure, and second low-pressure



CONDENSERS AND PUMPS, PINKSTON POWER STATION, GLASGOW.

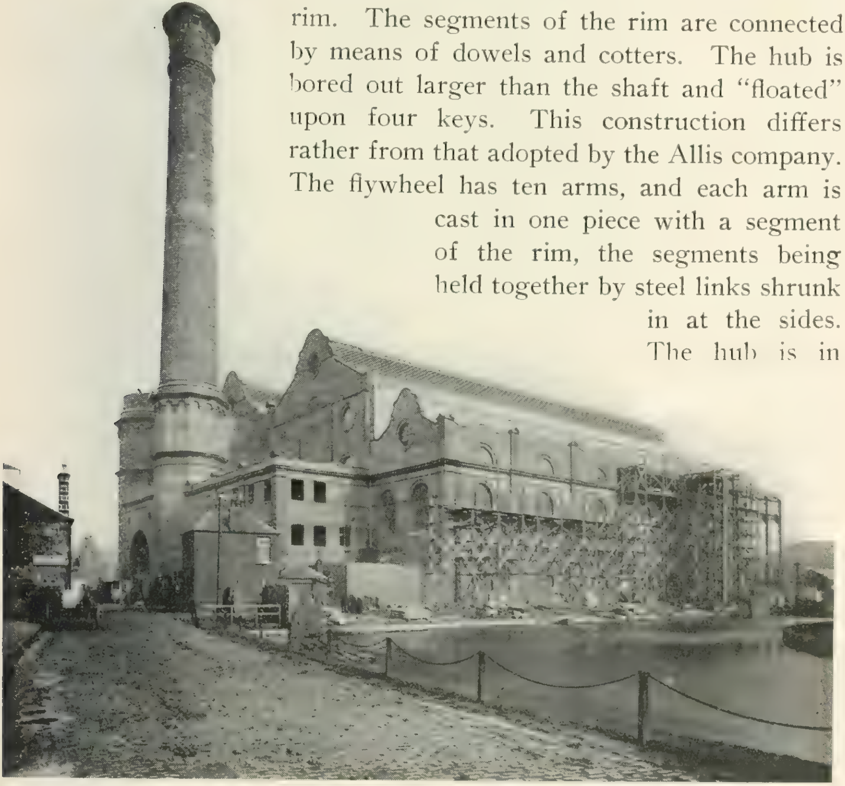
crank pins measure 14 inches by 14 inches, 18 inches by 14 inches, and 22 inches by 14 inches respectively. All the piston rods are 9 inches in diameter; the pistons are of steel with Ramsbottom rings. The valves are of the Corliss cylindrical type, double-ported both for steam and exhaust, and are actuated by the Musgrave roller trip motion. The cross-heads are of cast steel with cast-iron slipper guides and white-metal shoes. The main bearings are also lined with white metal and are fitted with water service throughout.

The crank-shaft and fly-wheel construction in these two engines is totally different. In the case of the American engine, the crank shaft is in three distinct portions, each cylinder practically working its own separate length of shaft. The various portions are not connected together rigidly at the first and second low-pressure crank pins, but these pins are fixed into one only of the crank webs, the other end of the pin having a certain amount of play in the corresponding web. With the Musgrave engines, the crank shaft is in only two parts, united between the first and second low-pressure cranks by a coupling, both low-pressure crank pins being rigidly fixed in both crank webs.

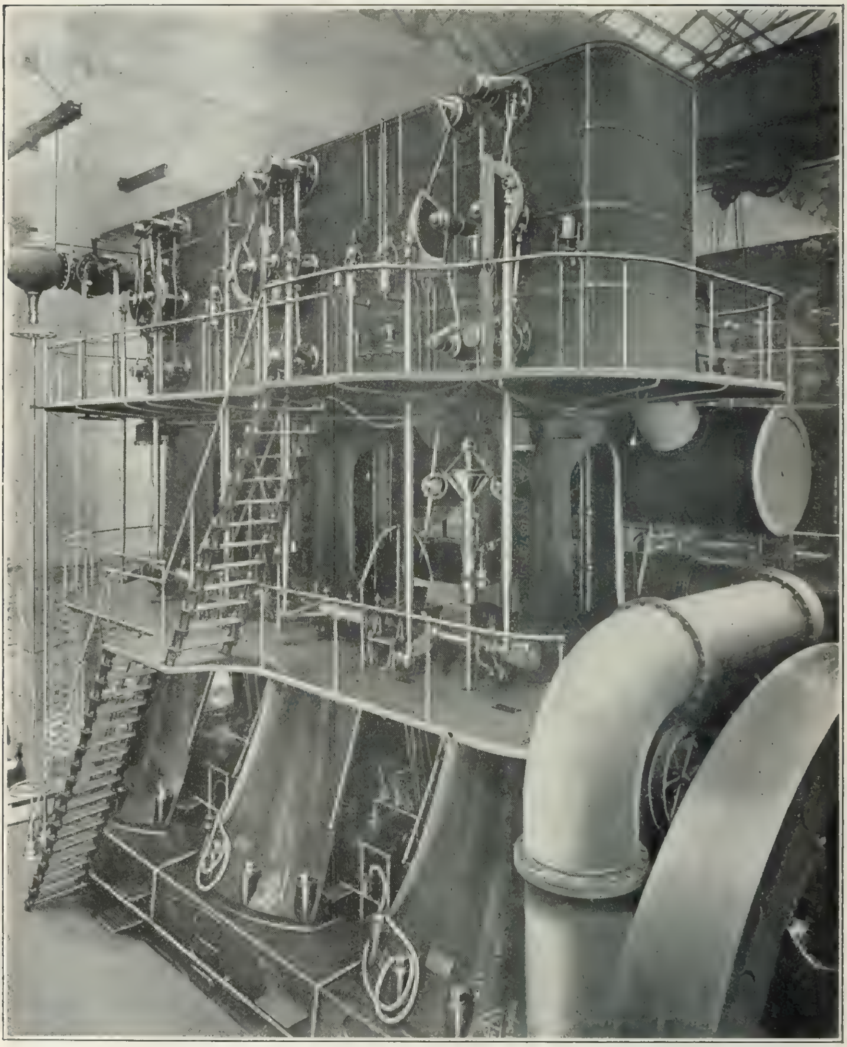
It is noticeable that in the Allis engines, a much greater proportion of the shaft is supported in bearings than is the case with the Musgrave; these bearings are of gun metal lined with white metal for the English engines, and cast iron lined with the same material for the

American. The latter are much closer built altogether and give an idea of greater simplicity than is conveyed by the appearance of the others. In the Allis engine all the cylinders are connected together, and there is no space in between them; the valves are placed at right angles to the line of the crank shaft. The valves on the Musgrave engines are placed parallel to the length of the engine, with the wrist plates and gear in between the cylinders, which are separate from one another. The American slide for the cross-head is bored out concentric with the cylinder to which it is bolted, and is also connected to the frames by bolts. The English makers use a single flat slide which is cast in one with one half of the A-shaped frame; they have also made their bed plate in five pieces, as against the Americans' four, but the method of connecting the parts together is similar.

The flywheel of the Musgrave engine is built up in segments; the arms are separate from the rim and the hub, being keyed into the latter and bolted to the rim. The segments of the rim are connected by means of dowels and cotters. The hub is bored out larger than the shaft and "floated" upon four keys. This construction differs rather from that adopted by the Allis company. The flywheel has ten arms, and each arm is cast in one piece with a segment of the rim, the segments being held together by steel links shrunk in at the sides. The hub is in



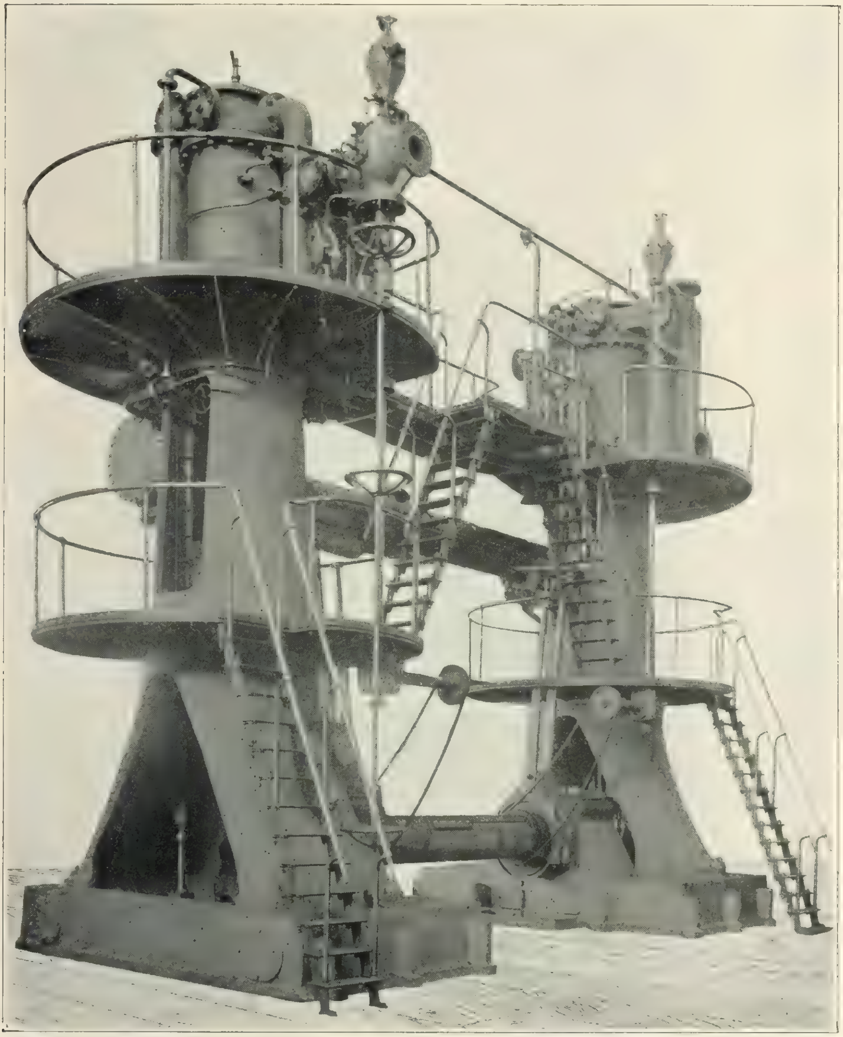
PINKSTON POWER STATION, GLASGOW CORPORATION TRAMWAYS.



GLASGOW CORPORATION TRAMWAYS. MAIN ENGINES.

Two Allis engines, three-cylinder-compound vertical, three cranks at 120°, cylinders 42, 62, and 62 by 60 inches, 4,000 horse power at 75 revolutions per minute.

two pieces, and the arms are let in and fastened by bolts arranged parallel to the shaft; the hub is forced on to the shaft by hydraulic pressure, and further secured by two keys. Another point of difference is that the governors of the Musgrave engine are situated on the bed plate, whilst the Allis governors are up by the cylinders. and so can work direct upon the valve gear.

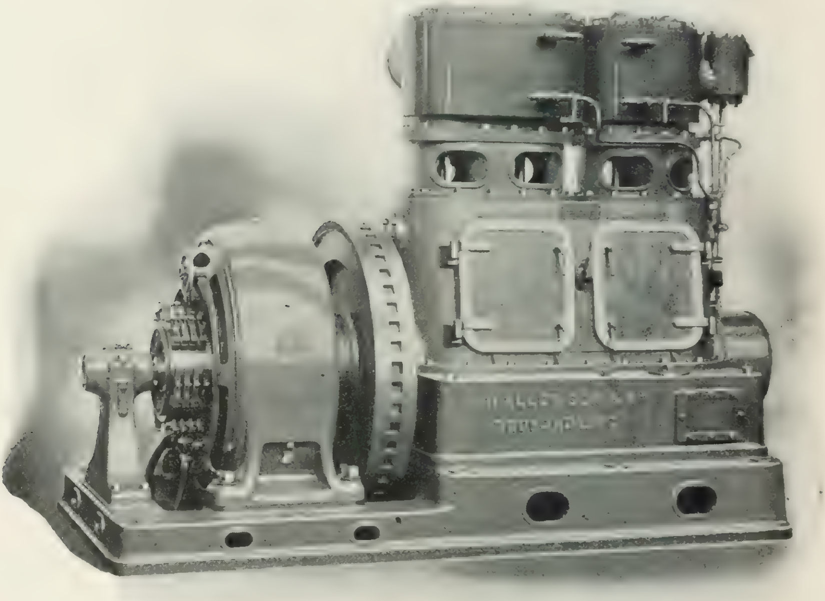


AUXILIARY ENGINES, PINKSTON POWER STATION, GLASGOW.

Duncan Stewart & Co.'s vertical cross-compound Corliss type, cylinders 22 and 44 inches by 42 inches stroke, 90 revolutions per minute, 800 horse power.

It is interesting to note that the British engine as made weighs nearly 100 tons more than was originally estimated, which makes it 50 tons heavier than the Allis engine.

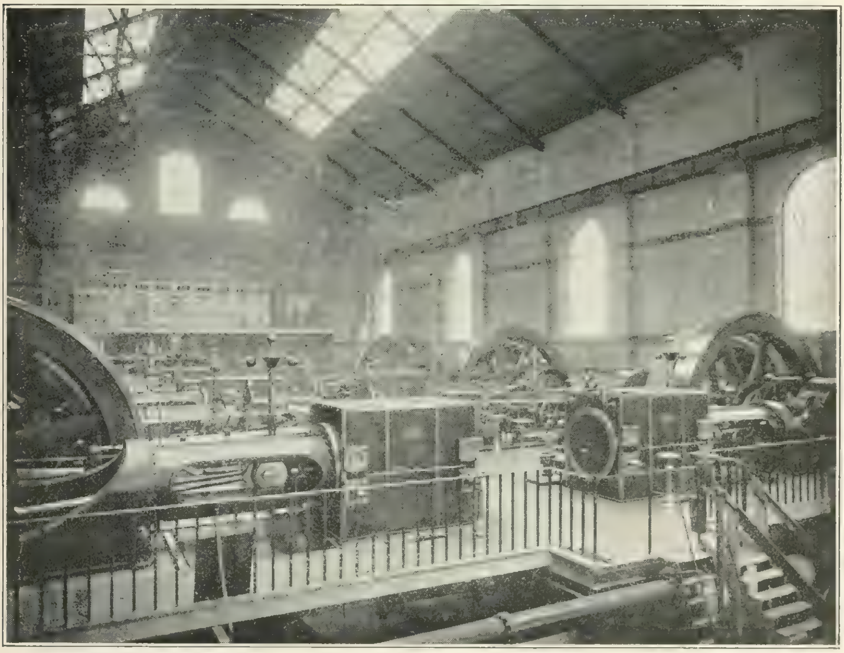
The auxiliary engines at Glasgow were supplied by Duncan Stewart & Company. They are vertical cross-compounded Corliss engines, and in size and design bear a very strong resemblance to the Allis engines which were recently installed for operating the Dublin electric trams. The following are a few details. The cylinders measure 22 inches and 44 inches in diameter by 42 inches stroke. The speed is 90 revolutions per minute. Both piston rods are 5½ inches in diameter; the crank pins measure 6½ inches by 7 inches, and the two main bearings are 18 inches in diameter by 36 inches long. The diameter of the crank shaft under the flywheel and armature is 20 inches. The flywheel is 19 feet in diameter and weighs about 34 tons, two-thirds of which is in the rim. The rim is in ten segments, each segment being cast with one arm. The hub consists of two flat discs, to which the arms are bolted, and the segments of the rim are held together by mild-steel dowel plates and cotters. The governors are of the high-speed Porter type; one regulates the speed whilst the other acts as a safety stop. The valve gear is of the Reynolds-Corliss type fitted with wrist-plate motion, and the trip gear is controlled by the governors. The engines have a normal working load of 800 horse power, and each is direct-coupled to a 500-kilowatt generator.



EXCITER ENGINE AND DYNAMO, PINKSTON.

W. H. Allen Sons & Co. high-speed enclosed vertical-compound two-crank engine, cylinders 11 and 19 inches by 8 inches stroke, 100 indicated horse power at 300 revolutions per minute.

In addition to the slow-speed engines already described, the power station at Glasgow contains six high-speed engines of British manufacture which run the dynamos for exciting the main generators. These engines were built by Messrs. W. H. Allen, Son & Co., of Bedford, and are of the enclosed high-speed compound type, with two cranks at 180 degrees. Each develops 100 indicated horse power when running at 300 revolutions per minute with a boiler pressure of 150 pounds per square inch. The cylinders, two in number, measure 11 inches and 19 inches in diameter by 8 inches stroke; the cylinders are cast separately and each is provided with one piston valve; they are mounted upon a cast-iron trunk which is provided with two hinged doors in the front. All the working parts are made of mild Siemens-Martin steel. The eccentric sheaves are forged solid with the shaft and have straps of cast steel. The crank shaft is 4½ inches diameter The main bearings and big ends are all lined with white metal, the shells of the bottom halves of the main bearings being made of cast iron, with steel caps. Forced lubrication is supplied by means of a special valveless oil pump worked from one of the eccentrics under



POWER STATION OF THE CENTRAL LONDON RAILWAY.

Six Allis engines, horizontal cross-compound condensing, cylinders 23 and 46 inches by 48 inches, 94 revolutions per minute, 850 kilowatts.

an average pressure of 25 pounds per square inch. The stationary field of the dynamo is mounted upon a continuation of the engine bed.

During the last few years, owing to the conservatism of English manufacturers, a large number of American engines have been imported into Great Britain. The following list gives some data of the most important of such imports. British manufacturers are, however, I am glad to say, waking up and at the present moment their deliveries are equal to, if not better than, those of American engine builders and their prices are from 15 to 25 per cent. lower, which is to say the least encouraging for Great Britain. What with trusts and the indifference to consumers' wants engendered thereby, and to the self-satisfaction and growing carelessness of American exporters, the British home producers may hope for better times.

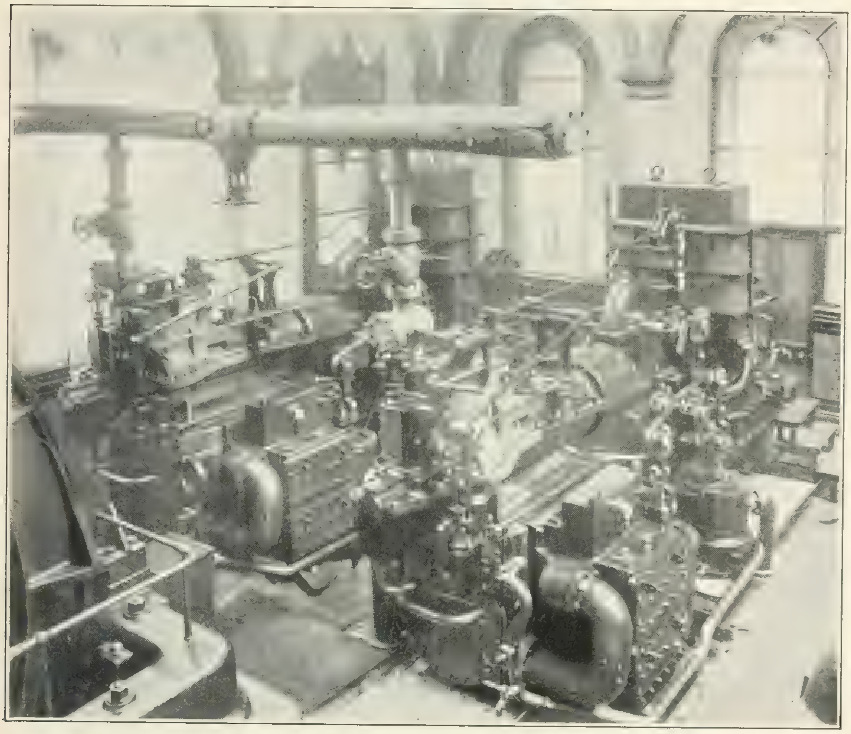
The following table gives some data concerning American engines which have been put in, in Britain.

Name.	Type.	Number Supplied.	Size.	Revs. per Min.	Power in K. W.
Central London Railway.....	H. C. C. C.	6	$\frac{23\ \&\ 46}{48}$	94	850
City Road Lighting Station...	"	2	$\frac{19\ \&\ 38}{42}$	100	525
Middlesboro Tramway........	"	3	$\frac{16\ \&\ 32}{36}$	100	300
Ellesmere Port Smelting Plant.	"	2	$\frac{19\ \&\ 38}{42}$	100	450
Bristol Tramways	V. C. C. C.	4	$\frac{22\ \&\ 44}{42}$	90	625
Dublin Tramways............	"	6	$\frac{20\ \&\ 40}{42}$	90	500
Bankside Lighting Station...	"	3	$\frac{28\ \&\ 60}{48}$	90	1000
London United Tramways....	"	4	$\frac{22\ \&\ 44}{42}$	90	625
Cork Tramways	H. T. C. C.	2	$\frac{15\ \&\ 30}{30}$	135	300
Isle of Thanet Tramways. ..	"	2	$\frac{14\ \&\ 28}{30}$	135	200
Sheffield Tramways	"	3	$\frac{12\ \&\ 22}{30}$	135	200
Glasgow Tramways	3Cyl. V. C. C	2	$\frac{42\ \&\ 62\ \&\ 62}{60}$	75	2500

H. C. C. C.—Horizontal Cross-Compound Condensing.
V. C. C. C.—Vertical Cross-Compound Condensing.
H. T. C. C.—Horizontal Tandem-Compound Condensing.

A few words of description of some of the recent plants for which the well-known British firm of engineers and contractors, Messrs. R. W. Blackwell & Co., Ltd., have supplied and erected power-plant material, will be of interest.

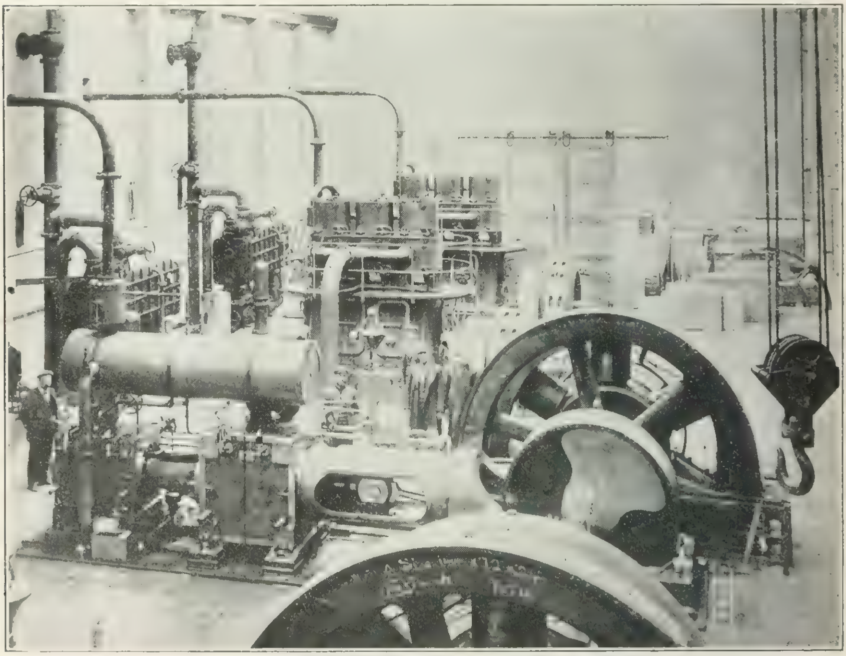
Central London Railway. The boiler house occupies a ground space of 148 feet by 87 feet. The upper portion is occupied by steel coal bunkers which have a capacity of 1,500 tons of coal. The bunkers are filled by means of an electrically driven Hunt coal conveyor, of the endless-chain type; the same conveyor is used to remove the ashes.



PARSONS TURBO-GENERATORS AT HALIFAX.

The coal feeds into the stokers by means of chutes. The steam-generating plant consists of 16 Babcock & Wilcox water-tube boilers arranged in pairs, with sufficient space left for four additional boilers. Each boiler has a heating surface of 3,580 square feet and supplies steam at 160 pounds per square inch pressure. The gases from the boilers go through four Green's economisers on their way to the smoke stacks. These last, which are made of brick work, are 200 feet high, with an internal diameter at the base of 10 feet. The boilers are stoked by Vicars mechanical stokers.

The engine room is 200 feet long by 86 feet wide, and contains six engines made by Edward P. Allis Co., of Milwaukee. These engines are of the horizontal cross-compound condensing type, with the generator mounted on the shaft between the two cylinders. The cylinders measure 23 inches and 46 inches diameter by 48 inches stroke, and each unit yields 850 kilowatts at normal load when running at 94 revolutions per minute, with 150 pounds per square inch steam pressure. The valve gear is of the usual Reynolds-Corliss type, with two eccentrics for each cylinder. There is a multitubular reheater receiver between the high- and low-pressure cylinders. The crank shaft, which is made of fagotted iron, is 22 inches diameter in the centre where the flywheel and generator are located, and 20 inches diameter in the bearings. The bearings are 36 inches long, the shells being lined with Babbitt metal. The flywheel is 18 feet in diameter, made in eight segments, and weighs about 100,000 pounds. The segments of the rim are held together by wrought-iron arrow-headed links shrunk in at the sides. The cross-head pins are 7 inches diameter by 7 inches long, and the crank pins are 8 inches diameter and 7 inches long, forced into the cranks and rivetted over. The connecting rods are made of forged steel and measure 12 feet between the centres.



ISLE OF THANET RAILWAYS POWER STATION.

Two Bellis engines of 260-325 indicated horse power, 300 revolutions per minute, and two Allis engines, horizontal tandem-compound condensing, cylinders 14 and 28 inches by 30 inches, 135 revolutions per minute, maximum continuous indicated horse power 480.

The high-pressure and low-pressure piston rods measure 3⅞ inches and 4⅞ inches in diameter respectively. The cross-head is made of cast iron, with babbitt-faced removable and adjustable shoes, turned and scraped to fit the bored slides.

The steam from the engines is condensed in six Allis jet condensers combined with the air pumps; each condenser has a capacity of 26,000 pounds of steam per hour. The condensed and injection water is cooled in four Barnard cooling towers, each tower being furnished with a pair of fans running at 180 revolutions per minute, which are driven by a Bellis engine. These towers are 50 feet high and have a diameter of 14 feet 8½ inches.

The Dublin United Tramways power station at Ringsend is also equipped with six Allis engines at 800 horse power each. These are of the vertical cross-compound condensing type, but otherwise do not differ in principle from those of the Central London Railway. The sizes of the cylinders are 20 inches and 40 inches by 42 inches stroke.

Isle of Thanet Light Railways. The boiler house and engine room are side-by-side and of equal size (134 feet by 50 feet). There is also a coal store 20 feet wide which runs the whole length of the building. In the boiler house there are four Babcock & Willcox boilers, arranged in two batteries, which supply steam at 160 pounds. Each boiler has a heating surface of 3,140 square feet; the steam drums measure 42 inches in diameter and are 7 feet long, and the boiler tubes are 18 feet long and 4 inches diameter. The feed water is heated in an economiser made by the Claycross Company. The boilers are hand-fired. The steam piping is lap-welded mild steel, the flanges being screwed on. The lay out of the piping is on the single-header system A duplicate system of feed piping is installed.

In the engine room there are two slow-speed Corliss engines built by the Edward P. Allis Company and two high-speed Bellis engines. The former are of the horizontal tandem-compound type, running at 135 revolutions per minute, with 150 pounds steam pressure. The cylinders measure 14 inches and 28 inches diameter by 30 inches stroke. Each engine has mounted upon its shaft a 200-kilowatt continuous-current generator, and is capable of developing continuously a maximum power of 480 indicated horse power. The crank shaft is made of iron hammered from selected scrap, and is 15 inches diameter at the flywheel and generator, and 13 inches diameter in the main bearing. This last is of cast iron lined with Babbitt metal, and is 19 inches long. There is also an outboard bearing of the same length The flywheel is 12 feet in diameter and weighs 22,000 pounds.

The crank pins are made of forged steel, 5½ inches diameter and 5½ inches long, forced into the cranks and riveted over. The cross-head pins measure 5 inches by 5 inches. The connecting rod is of steel with solid ends having wedge adjustments. The cross-head slide is bored concentric with the cylinders.

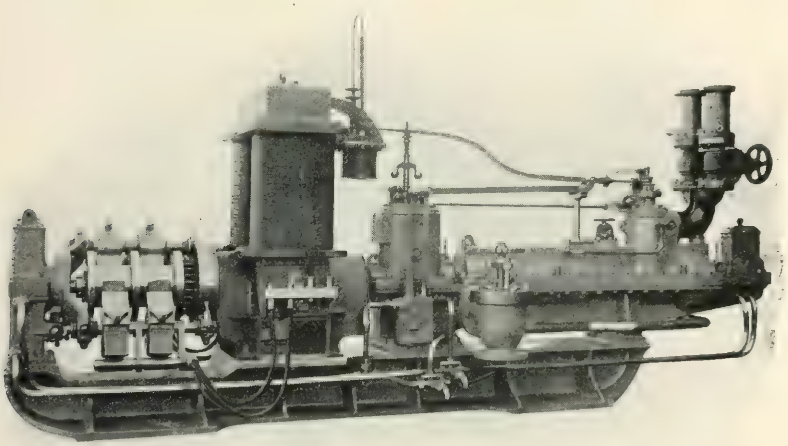
The high-speed engines are of the usual three-crank vertical-compound condensing enclosed type, made by Messrs. Bellis & Morcom. Each engine is capable of developing 260 to 325 indicated horse power with a steam pressure of 150 pounds and running at 300 revolutions per minute, and is direct-coupled to a 300-kilowatt three-phase dynamo.

The steam from the engines is condensed in three Wheeler surface condensers, with combined steam-driven air and circulating pumps, mounted underneath the condenser and on the same bed plate. The circulating water is cooled by means of cooling towers supplied by the same makers as the condensers.

I cannot complete the description of British steam-engine practice without a few words concerning the most remarkable steam engine of the present day, viz., the Parsons steam turbine, which has been remarkably successful and which may yet be destined to revolutionise steam-engine building on land and on sea.

The Parsons steam turbine in mechanical design is a radial-flow turbine. In construction it consists essentially of a drum revolving inside a cylindrical case, the axis of drum and case being the same. Upon the drum are mounted a series of blades arranged in rings round the drum, a certain amount of space being left between the rings. Corresponding blades are fitted in the interior of the case, being so placed that they fill up the spaces left between the blades on the drum. The tips of the blades on the drum just clear the inside of the case, and the tips of the blades mounted inside the case just clear the surface of the drum. The former are the moving blades, and the latter the fixed or guide blades. The turbine is governed by admitting the steam in a series of gusts by means of the periodic opening and closing of a double-beat valve. When the turbine is used to run a dynamo, an electric governor is employed, the duration of each gust being controlled by an electric solenoid, which is connected as a shunt to the field magnets. The action of this governor is so satisfactory that if the whole of the load is suddenly thrown off, the variation in speed is not more than 2 per cent.

The advantages claimed for the turbine are many. The space required to instal it is small, the first cost is low, and the upkeep and attendance are small. Owing to the absence of vibration, no costly foundations are necessary; there is no cylinder lubrication, and consequently the exhaust steam is entirely free from oil.



PARSONS STEAM TURBINE AT THE HOTEL CECIL, LONDON.
Direct connected to 75-kilowatt generator at 110 volts.

The following figures show some of the results obtained with a 200-unit turbo-dynamo.

TESTS OF 200-UNIT TURBO-DYNAMO.

Kilowatts.	Total water per hour. Lbs.	Water per kilowatt. Lbs. per hour.	Water per E. H. P. Lbs. per hour,	
219·2	9,466	43·20	32·22	Non-condensing.
98·7	5,848	59·23	44·18	
54·5	4,330	79·50	59·30	
0	2,092	.....	....	
203·0	8,429	41·52	30·97	Non-condensing and superheating 30 degs. Fahr.
106·1	5,287	49·83	37·17	
0	1,402	.....	.....	
208·0	5,443	26·16	19·51	Condensing but no superheating. Vacuum at full load 25 in.
108·4	3,037	28·02	20 90	
0	531	.... .	.....	

The difficulty in constructing turbo sets has been with the electrical portion. The high speed renders the construction of the armature and commutator in a continuous-current machine a very difficult problem. Turbines of 5,000 horse power are now being built and the tests show that for units of that size the economy as regards steam consumption is as high as with the best slow-speed engines.

My next paper will consider Continental practice and its salient characteristics.

THE DEVELOPMENT OF THE PETROLEUM AUTOMOBILE.

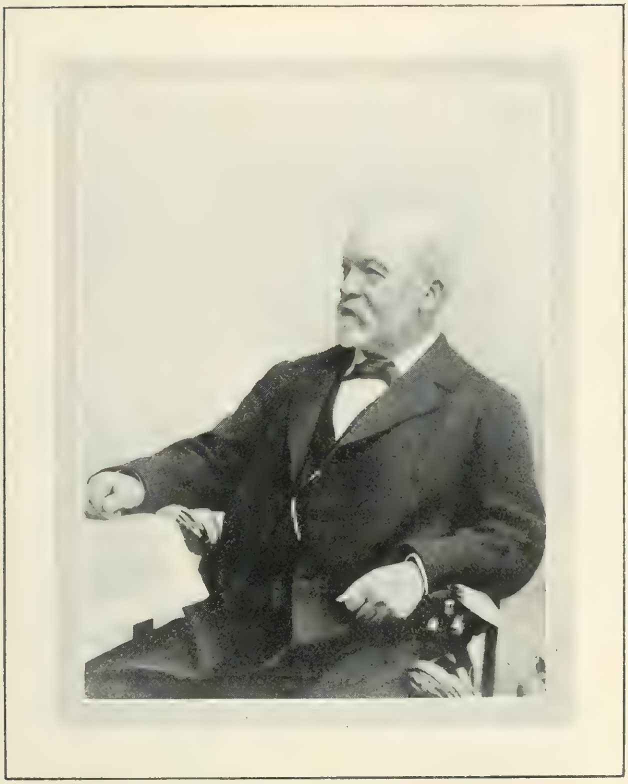
By Paul Daimler.

The fundamental work of the late Gottlieb Daimler in the development of the petroleum automobile is generally recognised in engineering circles, and it was the intention of the editors to have the story of his life work told by himself in these pages, the engagement having been made only a short time before his death. The present paper has been prepared from material left by him, and has had the careful revision of his son and successor, and hence is an altogether authoritative and representative account of the contribution of the "father of the automobile" to what has become such an important technical and commercial industry.—The Editors.

AMONG the various problems connected with the subject of mechanical locomotion in streets and on highways, the question of the motive power is admittedly the most important. Practically the motors for this service may be divided into three classes:—electric motors, using current from storage batteries; steam-driven motors, involving the carrying of some form of boiler; and internal-combustion motors, using benzine, gasoline, or petroleum as fuel. Electricity is limited to conditions where charging of batteries is practicable and where distances are moderate; steam has shown itself to be best adapted for slow speeds and heavy loads; while for general purposes, for all kinds of passenger automobiles and motor cycles, the internal-combustion motor has met with the greatest favour and success.

The development of this type of motor is historically bound up in the career of the late Gottlieb Daimler, so that he has been called "the father of the automobile," and a review of the work done by him will show the extent to which it has influenced modern automobile construction.

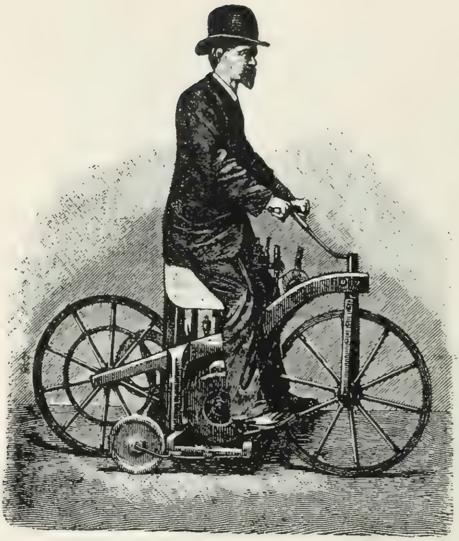
The internal-combustion motor, of which doubtless the best-known general form is the Otto gas engine, generally operates on the so-called "four-stroke" cycle. On the first outward stroke of the single-acting piston, the mixed charge of air and gas is drawn in; on the next inward stroke the charge is compressed; the compressed charge is then ignited, producing the outward power stroke; and the next inward stroke is the exhaust, clearing the cylinder of all products



GOTTLIEB DAIMLER.
"The Father of the Automobile."
Born at Schorndorf, Württemberg, 1834; died at Cannstadt, near Stuttgart, 1899.

of combustion. While this cycle gives a high degree of economy, it will be seen that such an engine must be larger and heavier than a steam engine which, to develop the same power, makes four times as many power-strokes in the same time. This fact at first rendered the internal-combustion engine altogether unsuitable for use as a motive-power for mechanically propelled vehicles, and it was originally employed for stationary purposes only.

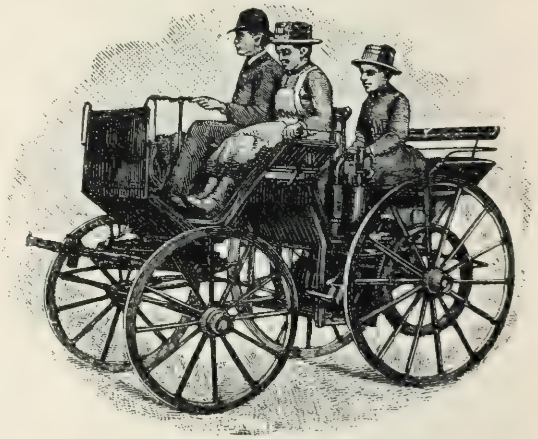
Gottlieb Daimler, after receiving a technical and scientific education at the Polytechnic School at Stuttgart, and a practical training in the Karlsruhe Machine Works, entered the newly founded Gas Engine Works at Deutz in 1872, and under his skilful direction this establishment, better known as the Otto Engine Works, grew in ten years from a small shop into a large, well-organised, and famous works. During his experience in this connection Herr Daimler gave careful study to



THE ORIGINAL DAIMLER MOTOR-CYCLE.

This vehicle, built and operated in 1885, is probably the first actual operative internal-combustion automobile in use, and was the forerunner of the modern motorcycle.

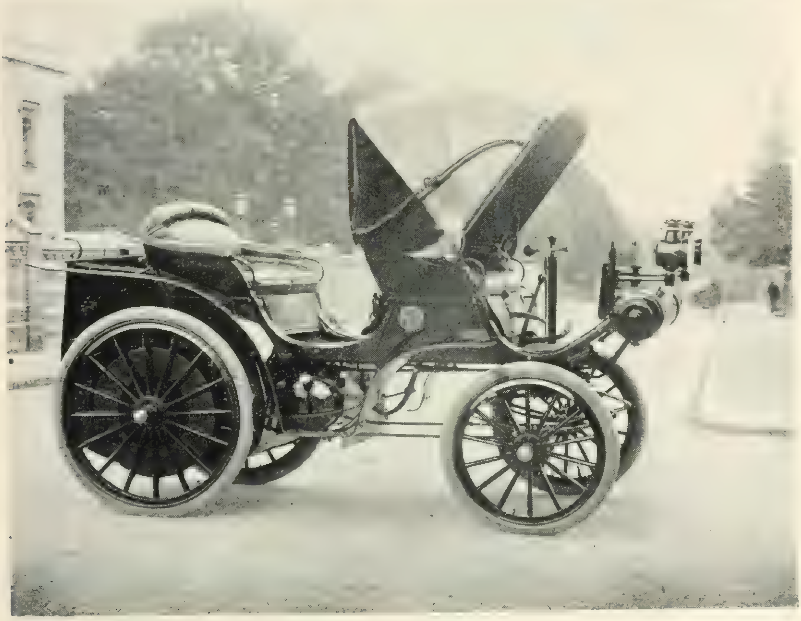
the improvement of the internal-combustion motor, and soon realised that if its relative size and weight were to be materially reduced the running speed must be greatly increased, this being the most obvious method of increasing the power without increasing the weight. The original Otto engine was provided with what was called the "flame ignition"—that is, the compressed charge in the cylinder was put into brief connection with a burning gas jet by means of a moving slide, the flame being blown out by the explosion and relighted from a fixed gas jet. This method of ignition limited the speed of the engine to a comparatively low number of revolutions, and it was this defect which Daimler sought to remedy.



THE FIRST DAIMLER MOTOR CARRIAGE.

The motor was connected to the driving axle by two belts, one for high speed and the other for hill climbing, either one being thrown into action by a tightener. Both could be thrown out of action to stop the carriage without stopping the motor. This vehicle was in successful operation in 1885.

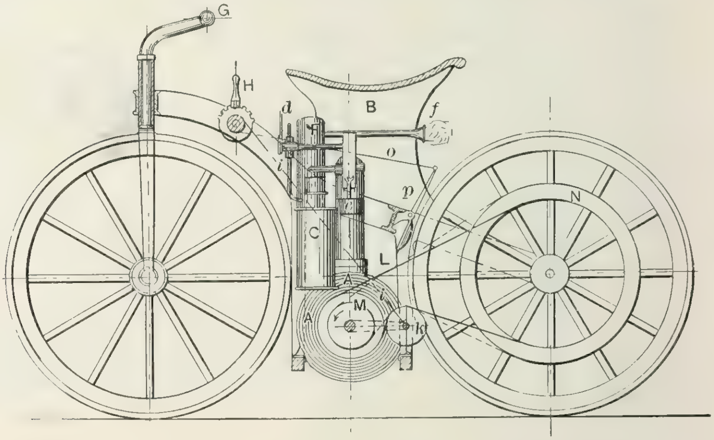
Instead of using the uncertain-acting flame with its inconvenient speed limitations, Daimler invented and introduced in 1883 the so-called "hot-tube" ignition. This consisted of a metal or porcelain tube attached to the compression space of the cylinder, in such a manner that the interior of the tube was in continual communication with the compression space. A gas flame, continually burning under the tube, maintained it at a glowing red heat, so that the mixed charge of air and gas, when compressed into the tube, became fully and effectively ignited. Experience showed that by a proper regulation of the temperature of the hot tube the ignition could be made to take place at any desired point in the compression, and thus the complicated, slow and uncertain slide flame ignition was replaced by a simple device, without moving parts, altogether satisfactory and reliable. The especial feature of the hot-tube ignition, however, was soon found to be the increased speed which it permitted. By its use the rotative speed could be increased eight to ten times over the older motor, and hence the weight could be reduced in nearly the same proportion. This fact at once showed Daimler that the application of the internal-combustion motor to mechanically propelled vehicles had become a possibility, and that, with the use of hydro-carbon vapour as fuel, and the high-speed hot-tube motor, the petroleum automobile might become a practical possibility. He therefore severed his connection with the Otto Engine Works at Deutz and, returning to Cannstadt, near Stuttgart, his early home, he devoted his entire time and atten-



DAIMLER VICTORIA.

For city and park driving and general private use.

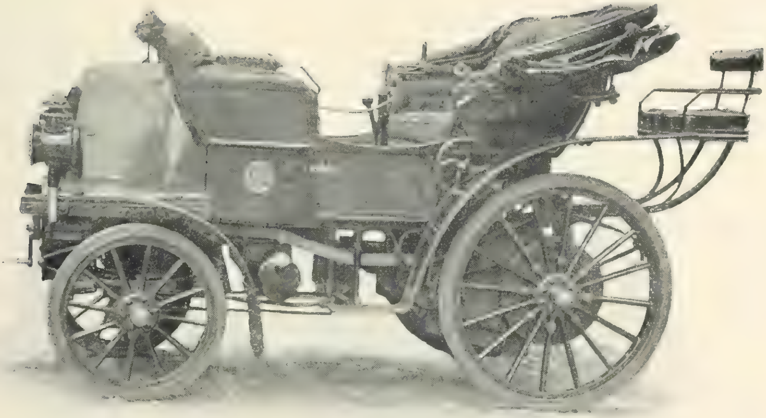
tion to the design of a light petroleum motor and motor vehicle. The result was the production, in 1885, of a motor-bicycle, shown on this page, of which the general construction is apparent upon inspection. The motor A was placed directly under the seat B, between the legs of the rider. The petroleum was drawn from the tank b, the supply being regulated by the valve d. The motor was first set in motion by lighting the lamp e and turning the crank a few times, the discharge passing through the chamber F and exhaust-pipe f. After the motor had been fully started, the vehicle was set in motion by moving the lever H, which drew the tightening pulley k against the belt L, and so caused the power to be transmitted from the pulley M to N. Changes of speed were attained by using pulleys of different sizes, similar to the cone pulleys on a lathe. This machine was put into successful action at Cannstadt on November 10, 1885, and is believed to be the first petroleum-driven automobile in practical use.



THE FIRST DAIMLER MOTOR-CYCLE.

Showing the position of the cylinder between the legs of the rider, and the arrangement of belt driving for starting and stopping.

The general arrangement of the motor itself is shown on the next page, which shows a section of the single-cylinder motor as arranged for stationary use. The simplicity of the machine is most apparent; there are but two valves, the inlet and the exhaust, and the ignition is effected by the compression of the charge into immediate contact with the tube L, kept hot by the external flame. When benzine is used as fuel the air is carburetted by contact, but when the petroleum is employed it is necessary to use a vapouriser. The carburetter is shown on page 363. The reservoir for benzine holds about 18 litres, the fuel

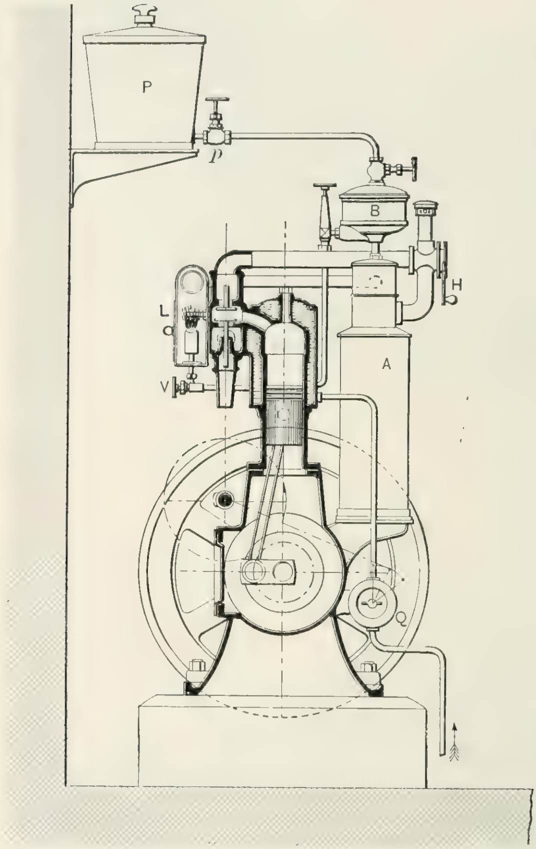


HEAVY VIS-A-VIS CARRIAGE.

This type of Daimler touring carriage has been successfully used by the *Oesterreichischen Touring-Klub* for mountain touring in the Tyrol.

DAIMLER MOTOR BOAT.

The first Daimler motor boat was built in 1886; the length was six metres, and with a two horse-power motor and a load of twelve persons it was propelled at a speed of 10 kilometers per hour without difficulty.



DAIMLER STATIONARY MOTOR.

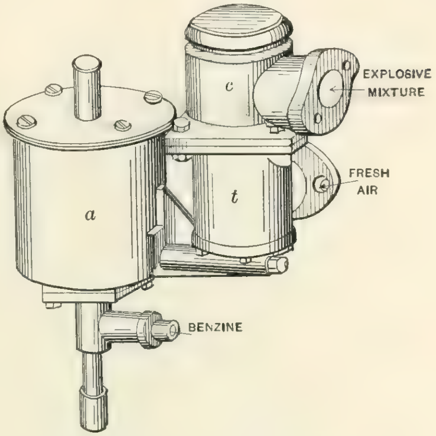
Giving an excellent idea of the simplicity of the machine, and the fewness of operative parts. The motor for vehicles is similar in construction.

being delivered to the carburetter by a pipe d, all impurities being caught by a sieve f. The flow is regulated by a float g, acting upon a pin-valve, a constant level being thus maintained. The benzine then passes through the pipe u and nozzle K, and with every suction stroke of the engine it is sprayed into vapour by the indrawn air, the cone l serving to disperse the mixture, and the proportions of air and vapour being controlled by regulating the air-admission openings. The external appearance of the carburetter is shown by the upper figure on page 363.

The general appearance of the single-cylinder motor as arranged for stationary use is given on page 364, from which it will be seen that very great simplicity has been secured. A still better form is shown on page 365, which has two cylinders inclined slightly to each other, and gives proportionately greater power for its weight. This especial form is that used for small boats and launches, but the principle and general construction are the same for motor vehicles.

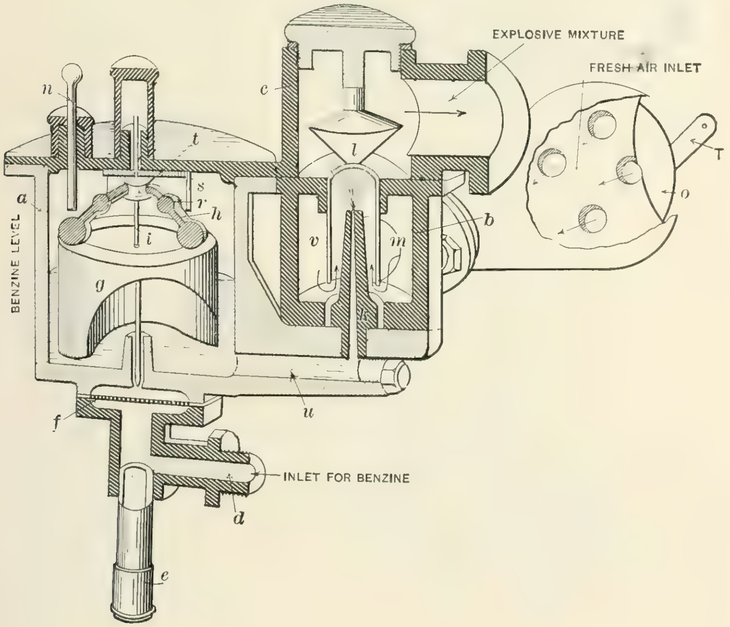
An interesting feature in connection with the Daimler motor is the arrangement of the cooling-water circulation for the cylinder jacket. The water is contained in a tank, from which it is circulated in the cylinder-jacket by means of a small rotary pump. From the jacket it passes to the cooler. This consists of a system of several hundred small tubes over which a blast of air is driven by a fan operated from the motor shaft. Since the speed of the fan increases with the speed of the motor, the cooling is proportional to the production of heat in the cylinder.

In addition to gas, which is applicable for stationary motors only, the fuel may be benzine of a specific gravity of 0.68 to 0.70, or ordinary lamp petroleum. The consumption varies according to the size of the motor, ranging from 0.36 to 0.45 kilogrammes per horse-power hour for vehicles, or somewhat less for boats. A variety of vehicles are shown in the accom-



EXTERIOR OF DAIMLER CARBURETTER.

Showing the entrances for air and fuel and exit for explosive mixture, as well as the general construction of the apparatus.

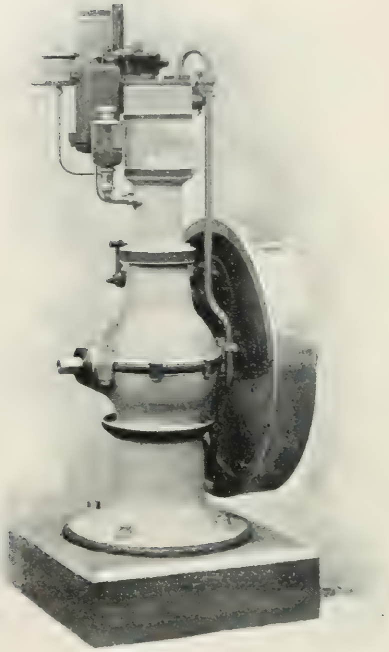


THE DAIMLER CARBURETTER.

The hydrocarbon fuel is drawn in by air suction and mingled with air against the cone, the explosive mixture being delivered to the cylinders ready for use as a gas.

panying illustrations, the arrangement varying according to the service required.

In this general review of the development of the internal-combustion motor as adapted to automobile vehicles by Daimler, it is interesting to note the various stages in the history of the subject.



SINGLE-CYLINDER DAIMLER MOTOR.

This is the motor as arranged for stationary service. The principle is the same for motor vehicles, with the absence of the fly-wheel and the introduction of the proper attachment to the frame

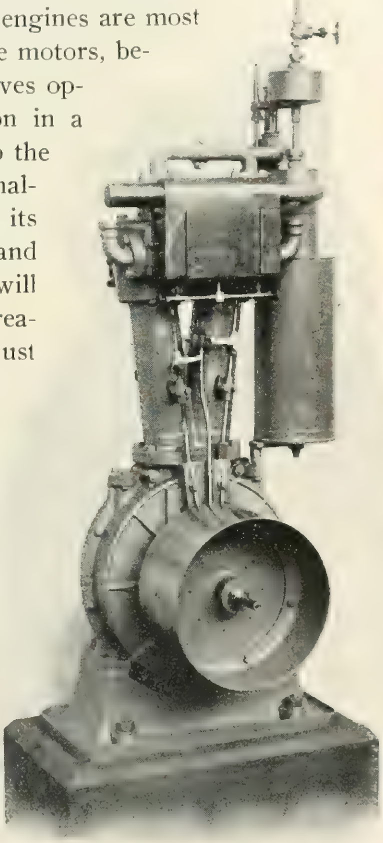
The application of mechanical power to vehicles for common roads had been attempted early in the nineteenth century, and at intervals thereafter, and while such machines as heavy traction engines using steam power found a limited application, the question of weight prevented the employment of self-propelled vehicles for general purposes. Sporadic attempts were made at the construction of motors adapted for vehicle propulsion, but until the work of Daimler, such machines were but the isolated attempts of their projectors and not efforts to produce commercial automobile vehicles for general use.

The first grasp of the fundamental condition of success lay in the realisation of the fact that the weight and size of the motor must be reduced by running it at a high speed, but this idea was of no practical use until it was followed up by the invention of a means for enabling the internal-combustion motor to be transformed from the slow, heavy machine of 1882 into the small, light, rapid motor of to-day.

Since the establishment of this fundamental principle the gasoline motor-vehicle has held its place against all rivals, and it is a matter of general knowledge that in all the long-distance and high-speed trials the vehicles equipped with internal-combustion motors, using benzine, gasoline, or spirit, have surpassed those using motors of other types.

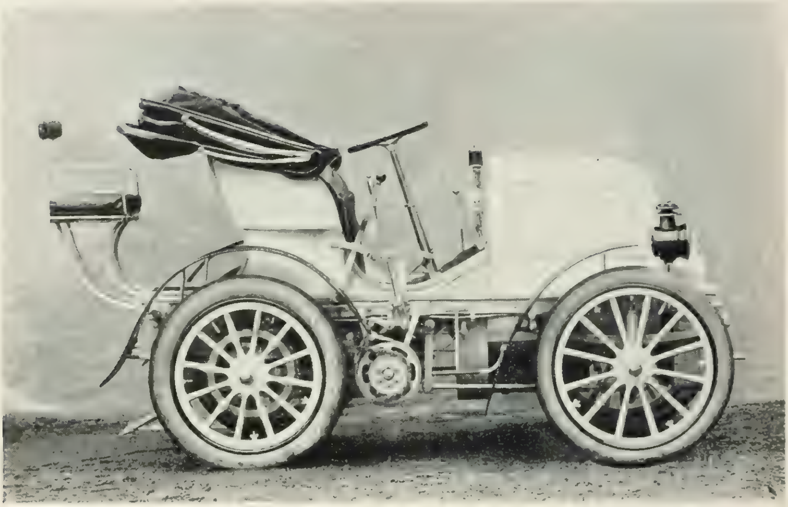
Light motor vehicles using steam as a motive power have succeeded just so far as they have approached the internal-combustion motor in general construction and operation, small high-speed engines, using steam of such high pressure as almost to approach steam-gas, being the most successful; but the presence of the boiler adds weight almost sufficient to make up for the superior advantage of the greater number of power strokes per revolution. Some of the most effective steam engines are most closely modelled after the gasoline motors, being single-acting, with poppet valves operated by cam and spring motion in a manner altogether similar. Up to the present time, however, the internal-combustion motor has maintained its lead for motor-vehicle purposes, and there is every prospect that it will continue to hold its position by reason of its inherent advantages, just as it is rapidly advancing in stationary service.

In this connection it is interesting to observe that it is the development of the light-weight, high-speed, internal-combustion motor which has made the dirigible balloon a practical possibility, furnishing a motive power sufficiently light in weight to permit the driving of propellers sufficiently large to enable the necessarily large air resistance of the gas bag to be overcome, and it is possible the motor may yet be so lightened as to make a self-lifting machine possible.



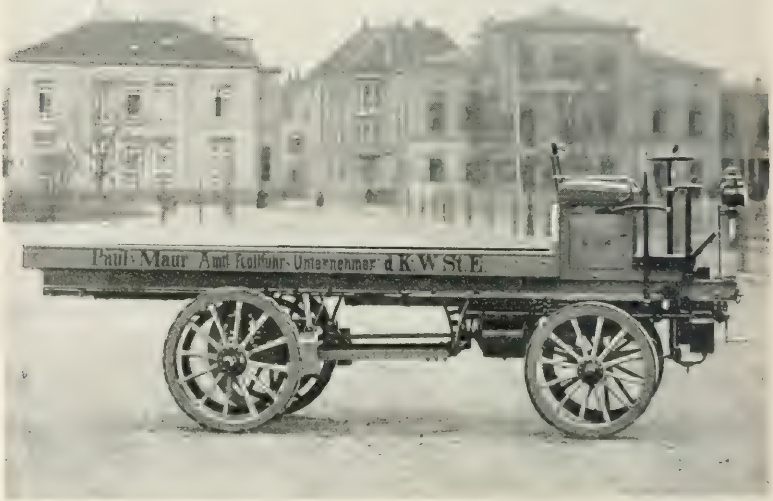
DOUBLE-CYLINDER DAIMLER MOTOR.

By the use of two cylinders the number of impulses per revolution, and consequently the power, is doubled, without a proportional increase in weight



DAIMLER MOTOR CARRIAGE.

A convenient form of automobile for city and general use.



DAIMLER MOTOR TRUCK.

Many of these are in use for hauling heavy merchandise, brewery service, etc. The one illustrated has a capacity of six metric tons.

THE PROPER DISTRIBUTION OF ESTABLISHMENT CHARGES.

By A. Hamilton Church.

VI. THE APPORTIONMENT OF OFFICE AND SELLING EXPENSE.

With this paper Mr. Church draws to a close a new and most valuable contribution to the applied science of cost keeping. The series of articles, which began in THE ENGINEERING MAGAZINE for July last, has included the following topical headings: The Interlocking of General Expense with Piece Costs; Various Methods of Apportioning Expense to Work; The Scientific Machine Rate and the Supplementary Rate; Classification and Dissection of General Shop Expense; Factory and Mass Production and the New Machine Rate; and (in this number) The Apportionment of Office and Selling Expenses. The whole discussion forms, to quote a fully informed critic, "the most thorough analysis of the theory and practice of machine-shop cost keeping yet attempted." THE ENGINEERING MAGAZINE has now under engagement, and will soon have ready for definite announcement, another most interesting study addressed to the interior of the shop, rather than the office—a study of the handling and tracing of large quantities of stock through the machine departments of the factory.—THE EDITORS.

IN the preceding articles of this series the question of shop or works charges has alone been considered. It has been shown that an improvement on the present practice of averaging these charges is possible, and that there is no reason why each item of product shall not be as definitely connected with its proper portion of such charges as with the corresponding portion of wages spent directly on it.

It was explained in the first article that shop charges do not by any means exhaust the whole of the expense account. In addition to the charges actually incurred in production, there is a large section of expenses incurred in advertising, warehousing, packing, transporting, and conducting the commercial processes incident to selling the finished product. These expenses should not on any account be mingled with those due to production.

In the case of a concern of which the works is in the country and the commercial office in the metropolis, this division of charges takes place naturally and almost automatically. We need not stop to discuss here the few minor points in which the division is indistinct; it will be sufficient to notice that there is for the most part a broad and strongly marked natural distinction between the two classes.

It has already been shown that the shop charges have a real relation to the work, and that all we have to do in their case is not to cover up or average away such real relation, but rather to seek to develop it. We have now to consider whether there is any similar real connection between the value of finished product and the general establishment charges.

It may be stated at the outset that there is no such connection. The cost of marketing an article has no ascertainable relation to the cost of making it. The immediate inference from this is that in whatever way we finally decide to distribute general establishment charges, a more or less arbitrary basis of incidence must be made use of. But this does not imply that there is no utility in discussing this basis very fully. On the contrary, the cost of selling requires as careful elaboration as the cost of producing, inasmuch as commercial ability is more rare and subtle than technical ability, and articles which are being produced cheaply enough may fail to show a profit owing to waste in the methods of finding a market for them.

The modern tendency to eliminate the middleman and sell direct from the factory to the consumer makes the question of general establishment charges one of growing importance. In some trades, as for instance the textile trades, where the product is sold to merchants mostly before manufacture, orders being taken in open market, ("on change"), the general charges bear a very small ratio to the finished article. But in proportion as the commercial side is developed and stocks are held, together with a great extension of advertising, travellers, and agents, these charges begin to loom large and may represent more than half of the ultimate sale price. The importance of knowing in such case precisely what it costs to sell, as well as what it costs to make, cannot be denied.

The theory of general establishment charges may be briefly stated as follows:—Having produced certain articles which are found to have cost N., we have to spread away over such cost an additional amount. M., which we find represents the cost of selling the value N. at a profit. Now the cost of selling has not, as already remarked, any proportionate relation to cost of making at all. And the real difficulty of basing the incidence of general charges on shop cost is that these charges do not get higher as works cost gets higher in the majority of cases, for the increase in cost of production is usually at the expense of profit. It is not often that the price obtained for an article is otherwise than ruled by the state of the market. And certainly accidental increases in production cost are at the expense of profit only in almost every case. If, therefore, we base the incidence of general charges as a mere percentage on wages, or on works cost, we are doing something which is very easy and simple, but which is almost sure to be very misleading in cases where there are more than one or two different classes of articles concerned. At the same time, it is evident that *some* basis of value must be taken before we can distribute at all. It is not practicable to isolate the expenditure on advertising, travelling, and so forth so as to debit each piece with the amount incurred on the selling of it; we have therefore to compromise the matter, and compensate the faults of the basis by a classification method which will enable us to discriminate between various classes of products. Even then there is a choice between three bases of value on which the general charges may be distributed.

General charges may be distributed: 1, on wages cost only; 2, on works cost; 3, on an hourly basis, according to the number of hours consumed in the production.

For ordinary manufacturing purposes, it is probable that the last method has the balance of advantages in its favour. The proposal will be understood if it is stated that the basis of distribution is an hourly-burden method. Also the entirely arbitrary nature of the basis will be strongly demonstrated. There is obviously no connection between selling expenses and the number of hours occupied in making. Neither is there any connection between wages, or prime cost, and the cost of selling. Many persons, however, are under the impression that there is. The reduction of the basis to hours instead of dollars or shillings will help to disperse this impression, which is of course without any foundation whatever.

Having decided on the basis for distribution, there is next the question of how to compensate for its arbitrary character. Its only merit is that it provides a common basis for distributing over classes of articles which may be very varied indeed, and it has, of course, a direct ratio with the activity of the shops during any period of which it is required to distribute the general charges. On the other hand, in cases where a factoring business in addition to a manufacturing business is done, or where the product includes heavy *purchases* of material, additional arrangements are necessary to deal with these variations.

If, now, we regard a given case in which there are, for example, three distinct products manufactured by the firm, one of which is a small item made in large quantities, and almost a "staple"—that is, a readily marketable product depending on the condition of the market for its sale and price rather than on any special efforts of the commercial arm to push it—the others being respectively an ordinary engineering device such as a lathe or pump, fairly well standardised and sold from catalogue, and finally a special class of thing, such as a crane, which has to be treated individually, involving a good deal of staff time for drawings, measurements, consultations, visits, etc., in each case—if we consider a case like this, it will be evident that to treat each of these classes alike in the proportion of general charges debited to it will be to do a serious injustice to the more easily sold things, to the benefit of the less easily sold. And when the question of what class of business it pays best to exploit is under consideration, this becomes a vital matter indeed.

It may perhaps be suggested that no system of establishment charges is required to inform a practical man on this point. And in the strongly contrasted cases which have been purposely selected, this may perhaps be so. But in proportion as the difference between classes becomes less, the problem becomes obscure. A shrewd guess may be made, and in the absence of actual knowledge must be, as to what is the most profitable class of several. The whole tendency of modern organisation is, however, to do away with the necessity for guessing at all.

It is necessary, notwithstanding, to beware of relying on figures unless the conditions under which they are true are well known. A misleading method is, of course, much worse than none at all. It is for this reason that the essential falsity of averaging general charges all round should be clearly recognised, just as it has been shown that the method is false for shop charges. And when, as is usually done, *both* these classes of charge are lumped together and averaged away over the work without any differentiation at all, it is difficult to avoid the conclusion that the practice is a dangerous one.

This caution is necessary at the point we have reached in the discussion of methods of dealing with general establishment charges. It is not pretended that the system here described is as final and accurate as the method of dealing with shop charges. These latter are real, and their connection with each item of work is also real. But as has been frankly admitted at the outset, the connection of general charges with work is not real, but entirely arbitrary and conventional, from the very nature of the elements concerned. All we can hope to do is to approximate the figures to the actual facts, by further artificial means. Therefore the proportion of general establishment charges debited against any particular order must always be regarded with due reservation.

The most practical method of correcting the errors introduced by the artificiality of the basis of distribution, is by means of classification whereby the incidence which would otherwise fall equally on each kind of work is made to fall unequally. A number of classes are created, the incidence in the first of which is, say, 100, the incidence in the second being 120, that in the third and fourth perhaps 150 and 170 respectively, and so on for as many classes as may be found necessary. Leaving aside for the moment the considerations which determine in what particular class any given article shall stand, it is evident that if we have a thousand dollars to distribute, the first class will get off lighter and the last class will be more heavily debited than on an ordinary averaging plan. Therefore if any reasonable means of classifying articles can be devised which shall correspond as closely as possible to the differences in their commercial treatment, the arbitrary character of the original basis will be to a large extent minimised. There still, however, remains the objection which must never be lost sight of when consulting the figures, that an undue rise in production-cost will lead to a disproportionate absorbtion of general charges, in whatever class the article may happen to be.

The process of determining the classification is, unfortunately, somewhat difficult, or at least demands a good deal of thought and care at the outset. Space will not permit of its full treatment here, only the principle followed can be detailed. Every item of general charges must be tabulated. The average annual cost of advertising, travelling, drawings, patterns, catalogues, correspondence department, cashiers and book-keeping, management, and all similar expenditure must be got out and arranged in columns. These are the items of which the incidence has to be settled. Now against these has to be placed each of the different classes of articles manufactured, and each one of these has to be carefully reviewed with relation to each of the items of expense.

Thus, for instance, advertising. Analysis of the advertising expenditure may show that one article has practically no concern with advertising. Of this class an obvious example is repairs to the firm's own products. Other articles, on the contrary, may involve special advertising, and should of course be debited with the whole of such special expense. Catalogues are open to similar analysis. Such items, again, as are standard articles supplied either from stock or from standard parts, involve much less of the expenditure due to correspondence than do special jobs. Repairs, on the other hand, although escaping the advertising debit, should be visited heavily on the correspondence and book-keeping sections, since these small jobs cause as much work to these departments as do standard orders of fifty or a hundred times their value. From this brief description it will be seen that the general establishment charges are capable of a very detailed analysis. It is true that the element of judgment is very strongly involved in this analysis, but there is a difference between judgment and mere guesswork. There is no reason why a very close approximation to facts should not be made at this stage if the work is carried out by a competent person, who has access to all the data necessary for decision.

The method of working up the analysed details into percentage figures on which the distribution of general charges is actually made will be better understood from an example. In the following table only three classes of articles have been taken, and only three out of the many items of establishment charges. The principle will be none the less clear.

TABLE SHOWING METHOD OF APPORTIONING DIFFERENT ITEMS OF GENERAL ESTABLISHMENT CHARGES ON DIFFERENT CLASSES OF WORK.

Class.	Output.	Advertising Exp.	Catalog Exp.	Correspondence Dep. Exp.	Totals.	Percentage of Incidence.
Standard lathes......	$100,000	$7,000	$4,800	$1,660	$13,460	13½
Special cranes.......	20,000	3,000	200	1,340	4,540	22¾
Repairs.............	20,000	....	......	2,000	2,000	10
Totals.........	$140,000	$10,000	$5,000	$5,000	$20,000	*

* Average percentage would be 14¼ per cent.

The figures in the expense columns of the above table are obtained by carefully considering the items with reference to the output. Thus, on examining the advertising account, it was found that $3,000 was spent in advertising special cranes, leaving the remainder of that expense to fall upon the standard lathes. Catalogues, again, not containing more than a mention of the cranes, were adjudged to be borne almost entirely by the lathes. On the other hand, when the work and expenditure of the correspondence department was reviewed, it seemed just to apportion the expense much more equally between the three classes. The result of these several apportionments, having been summarised for each class and the ratio established between them and the volume of business done, it is found that while as might have been expected the standard lathes which form the great bulk of the output absorb very nearly the average amount of incidence, viz., 13½ per cent. instead of 14¼ per cent., the other classes, viz., cranes and repairs, differ considerably from the average, the former taking nearly 23 per cent. and the latter 10 per cent.

In distributing general charges each month, effect is given to these percentages. The total expenditure being found, it is not averaged indiscriminately over the whole output for that month, but in such a manner that when all is distributed the proportion between the various classes is maintained. This is done by a very simple calculation, not demanding in its practical working anything more than common arithmetic. The result obtained is decidedly instructive. Assuming that the classification has been carefully made, the relative profitableness of any class of work can be ascertained. And if at any time it is found necessary to revise the percentage for any class, this can be done without disturbing other classes. For, as will be seen from an examination of the table above, if the percentage of any class is slightly reduced, it fails to absorb so large a proportion of the expenses, which consequently fall more heavily on all the other classes.

It must not be overlooked that a fundamental principle of the distribution is that the debit for general expenses shall be exactly cleared by the total of the allocation to classes. The percentages here express merely the *relations between the classes,* and not any definite percentage on values. If one class takes 10 per cent., another 15 per cent., and a third 20 per cent., this merely means that the general expenses, whatever they are, are distributed on the basis of that *relative* difference between the shares taken by each class. It does *not* mean that Class 1 gets 10 per cent. only on its value, but that if Class 1 gets a certain burden, Class 2 has one-and-a-half times and Class 3 twice as heavy a burden in proportion to hours or value. That is, if Class 1 has a burden of 4 cents an hour, Class 2 will have 6 cents and Class 3 will have 8 cents. The actual burden will, of course, depend on the amount to be distributed.

If then we find that any particular class is absorbing expenses to such a tune that there is no profit left when prime cost, shop charges, and general charges have all been debited, a prima-facie case is made out for supposing that this class is not remunerative at the prices obtained. Before we can say that this is actually so, the basis of classification must be carefully examined to see if it has been assessed with undue severity on that article. This will perhaps involve some trouble, but it is eminently a case in which it will pay to spend trouble.

Between the shop charges and the general charges there is, then, this difference: While the first, if properly arranged in the first place, are subject to no appeal, as they are real figures and do show exactly what has taken place, the general charges may be looked on as rather in the nature of a danger signal which gives warning of a probable pitfall, but which may, if careful enquiry approves, be put on one side and its readings modified. It would be better, of course, if the figures pertaining to general charges were as real and reliable as those of the shop charges. But there seems to be no possible hope of their being made so. There is no visible and tangible result connected with concrete things in the case of general charges. Nothing is produced. Expenditure may, in fact, lead to no result at all—nay, does often lead to pure loss of money and time. It is this vagueness of the general charges that forbids our regarding them as bed-rocks on which we can base deductions without further enquiry. But there is no excuse for not making them as useful as possible, reading them as indications if not as facts.

Enough has, perhaps, been said about the character of these general charges to emphasise the remarks which have been made several times in the course of these articles as to the infinite importance of separating them from the shop charges. Mr. Slater Lewis's theory on this point is very clear and distinct, and should be studied by every manufacturer who cares for accuracy and clearness in place of confusion and mixed results in his accounts. It is not too much to say that any system of accounts which lumps both classes of charge together and averages them all round is entirely worthless. Far from being an improvement on a simple system of prime cost, it is probable that it may easily, by inducing a false security, be positively dangerous and worse than no system at all.

The conclusion of this series of articles has now been reached. An attempt has been made to develop in an orderly manner the method of dealing in an improved way with the very difficult subject of establishment charges. Endeavour has been made to show that present methods are not satisfactory in that they seek to mingle elements which have nothing in common, and which are, on the contrary, naturally distinct. In particular it has been shown that the old idea of the machine rate was based upon a theory essentially correct, but incomplete. It fulfilled functions which were seen to be desirable, and which have been altogether neglected in the more modern methods that have succeeded.

The fault of the machine rate, or perhaps we may say its misfortune, was that it was born and came to maturity in the archaic ages of cost accounting, and that it therefore sinned against the most serious canons of modern theory and practice, viz., that whatever else is done, *every dollar of charges must be burdened onto some item of work.* The machine rate failed because in the first place it dealt with only one or two items of expense, usually interest and depreciation alone, and in the second because in the case of idle time it simply lost sight of the charges which were nevertheless still there.

The main feature of the system proposed, as will have been gathered by those who have followed these papers, is that not only do the new machine rates deal with nearly all items of shop charges on a natural basis, but by the device of the *supplementary rate* all the lost time is picked up and distributed separately, thereby leaving the significance of the machine-rate figures unalloyed by the accidental conditions of the shop at any time. Further it has been shown that the supplementary rate forms in itself a useful barometer of conditions.

Although necessities of space have prevented a full discussion of the complex subject of general charges, enough has perhaps been said to show that the principle of averaging is not the best possible. It has been demonstrated that a certain amount of connection can be developed, not between general charges and *individual articles,* but between such charges and *classes of products.* And while the results are not as precise and indisputable as in the case of shop charges, there is still a decided gain by effecting this connection as far as it can be done, the results being looked on as in the nature of a guide or warning rather than as positive and definite information.

The whole tendency of what has been said is to the effect that by suitable arrangements on the lines proposed, manufacturers should be in a position to get much further into touch with the details of their work than they have any chance of doing on present methods.

A few final observations may be offered on the subject of works accounting generally. Modern methods have taken their rise in the growing complexity of modern industry. They, like the industry itself, tend to become more complicated in proportion as the numbers of their factors increase. The snare of the "simple system" must therefore be avoided. One cannot calculate the weight of the earth or the distance of Uranus by means of common arithmetic. Nor can anyone represent the thousand-and-one interlocked factors of a modern factory by means of a double-entry ledger and an office boy. And just as the whole science of navigation hinges on high mathematics, so the management of a considerable business turns upon intricate principles which are the horror of the rule-of-thumb man and the sheet anchor of the progressive man of business. Now one can traverse the Atlantic in an open boat and without the Nautical Almanack, but it is done more quickly and more surely in the Oceanic.

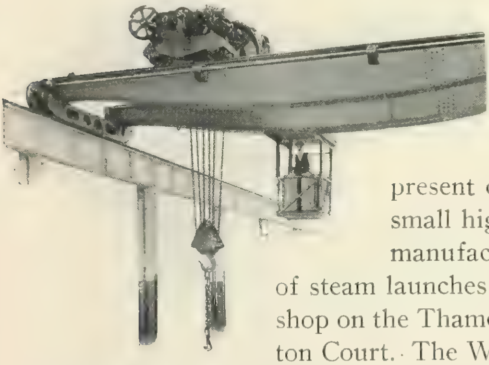
No system, however good, will give immediate results. It must be established, and must have run smoothly for months and even years before the full advantages are realised. For all progress is made by comparing what was done today with what was done some time ago, and this can be done to any purpose only when the basis of comparison is similar. From the nature of the case, no spasmodic efforts at the introduction of new methods are of the smallest use. To be of final and real commercial and technical value, records must be continuous and extend over various fluctuating periods of trade.

It will seem superfluous to many who read these lines to insist on the necessity of connecting the establishment charges as closely with costs as it can possibly be done, yet the truth is that comparatively few manufacturers are awake to this necessity. They do not realise that in all industries it is the narrowing of margins of profit, too often to the vanishing point, that has brought this question to the front. Fifty years ago, though there was a need (as evidenced by the tentative introduction of machine rates), there was not a pressing and imperative necessity for the manufacturer to look so closely and minutely into what he was doing. And only the "coming men" feel that necessity now. The older concerns will probably never come to that point, for they will have become exhausted in the effort to find out what was wrong with them.

ADVANCED METHODS IN A BRITISH ENGINEERING WORKSHOP.

By A. Lazenby.

In the great Works Management Number of The Engineering Magazine, which appeared in January of this year, the first place was given to a study of "Lord Armstrong and the Elswick Works." Elswick was chosen as most typical of the historic engineering works which made England famous around the world, but especially as best representing the embodied genius of a single great inventive and organising mind. The works themselves are an example of growth by accretion. The Victoria works, described in the following pages by Mr. Lazenby, are characteristic of the newer age of British engineering progress. They stand, so to speak, as an example of growth by re-incarnation, and in this process they have been enabled to discard wholly everything obsolete and to build anew according to the latest ideals of practice. They stand naturally, therefore, as one of the best recognised examples of advanced British workshop management, and it is from that point of view they are treated here.—The Editors.



THE firm of Willans & Robinson originated about twenty years ago in a partnership between the late Mr. P. W. Willans and Mr. Mark Robinson, the present chairman. Their specialty was a small high-speed marine engine, with the manufacture of which they combined that of steam launches and boilers, in a small river-side shop on the Thames at Thames Ditton, near Hampton Court. The Willans launch engine was the first high-speed engine which was really successful both as regards durability and economy, so much so that on the advent of electric lighting in Britain the suitability of the engine for the direct driving of dynamos was at once recognized. To fit it for this purpose, however, an important addition was made to it, in the form of the now well-known air-cushion cylinder, the invention of Mr. Robinson, and with this modification it came quickly into use for driving dynamos in Great Britain.

Various other improvements and modifications were made by Mr. Willans, which ended in 1884 in the evolution of the firm's present product—the Willans & Robinson central-valve engine. For many years past they have devoted themselves to it exclusively, the launch-engine business having been entirely given up.

In 1888 the firm was transformed into a private limited company, and in 1893, further expansion becoming necessary, the company was reconstructed with a larger capital. A site was purchased at Rugby, where excellent railway facilities as well as room for growth were available, (advantages which were both absent at Thames Ditton,) and the present shops were erected. Work was started in them in 1897, and already in the short space of three years several extensions have been made and a much larger one is now in progress, involving a doubling of the machine shop and a trebling of the foundry.

The new works well illustrate the leading principles which have guided the company since its earliest days, and which have contributed in no small degree to its success. They may be summed up in few words as follows:—the production of the highest quality of work attainable; the standardisation of the engine into certain definite sizes; strict accuracy of work, and interchangeability of all corresponding parts of the same size; adoption of all suitable labour-saving appliances and means for cheapening production; and the cultivation of good relations with, and care for the welfare of, their employees.

The works are situated upon a piece of land of about 23 acres in extent which adjoins the London & North Western Railway, near Rugby station. It was the company's aim in laying out the works, firstly, to arrange them so that the raw material entered at one end and in going through the various processes traveled more or less con-

ENTRANCE HALL, WILLANS & ROBINSON WORKS.

THE OFFICES AND GROUNDS OF THE VICTORIA WORKS, RUGBY.

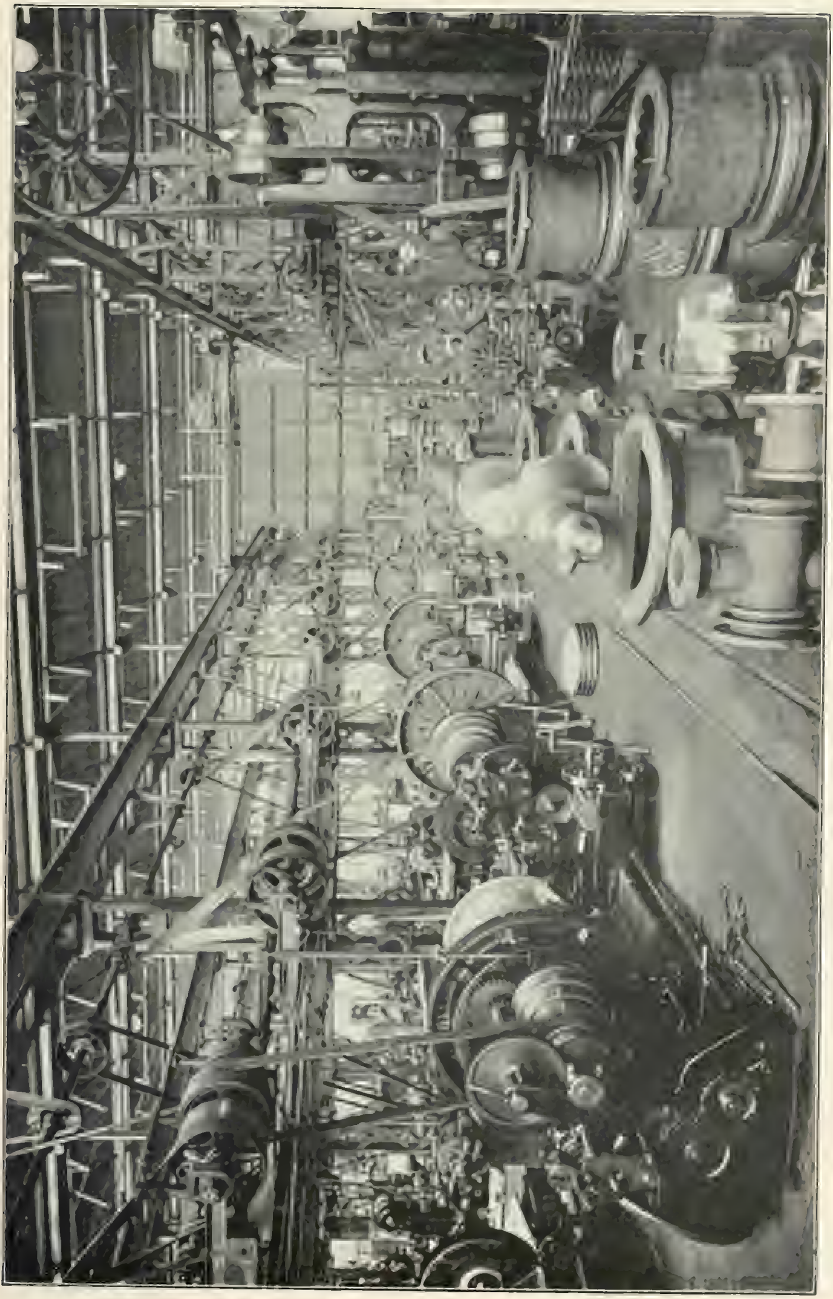
tinuously in one direction through the works until it emerged in the shape of finished engines, or portions of engines, ready for despatch at the other end; and secondly, to make provision for easy extension, should it become necessary. The buildings were therefore designed to front upon a road which extends across the entire site, running nearly parallel with and close to the lines. The order of the principal departments starting from west to east is as follows:—

1. Foundry, with storage for coke and iron.
2. Casting stores.
3. Machine shop.
4. Manufactured stores.
5. Erecting shop.
6. Packing and forwarding department.

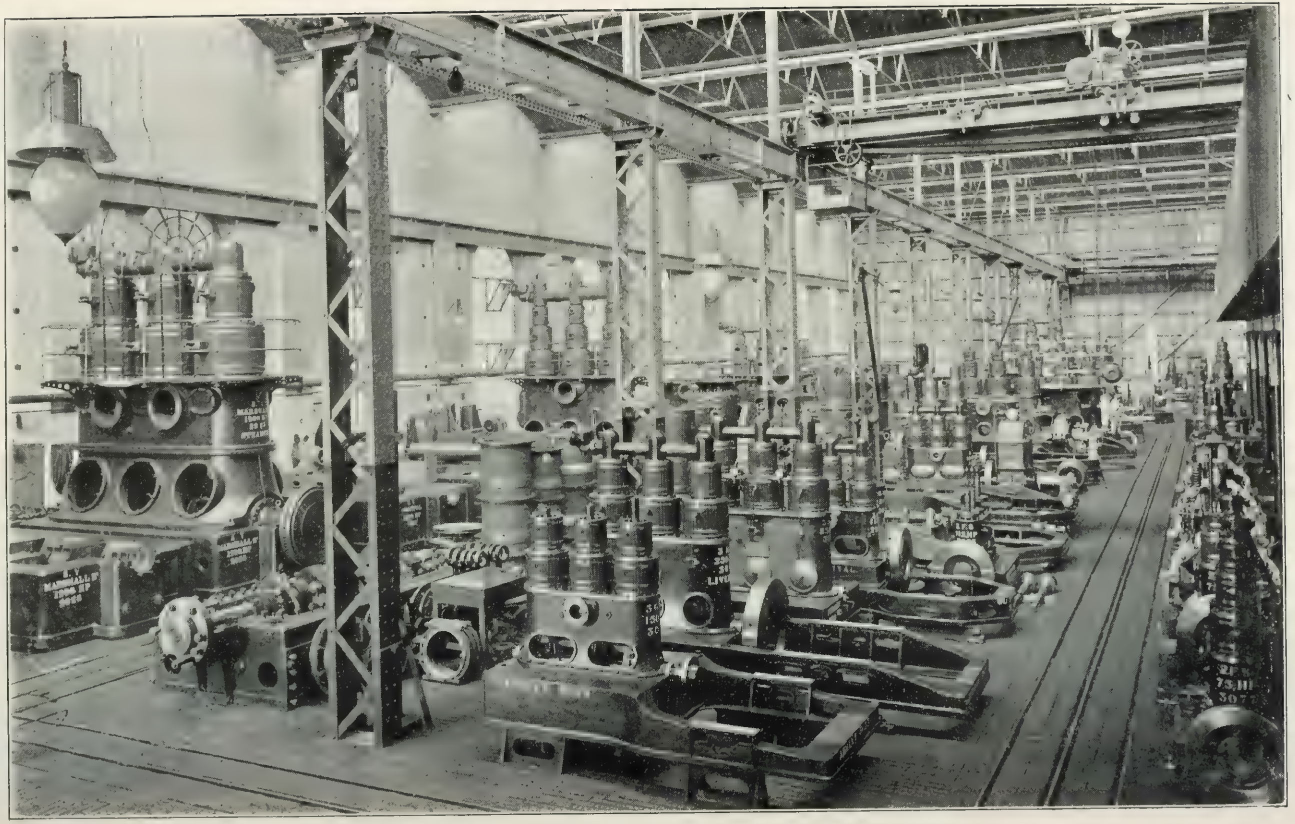
Beyond these again are the pattern shop and stores and the general offices, while the testing department is housed in a separate building some little distance away and connected with the erecting shop by a tramway. The buildings are all constructed upon one uniform plan; they are one storey in height and are divided into bays running north and south, separated from one another by lattice steel stanchions which carry the traveller girders and shafting. They also carry the roof, which is of the weaving-shed type with the light entering from the north, and having the ridges and gutters running east and west. The buildings are incapable of extension sideways, but they may be lengthened backwards, i. e., to the south. The machine shop has already been twice lengthened in this way, and the foundry and the shop formerly intended for boiler making are now being greatly extended in the same manner. At the western end of the works stands the foundry with coke and iron stores on its western side, in the middle of which runs a railway track; at this side also are the two cupolas and the blowing engine. The building at present covers 22,000 square feet, which will be extended to 57,000 when the extensions in progress are completed.

ONE OF THE DIRECTORS' ROOMS.

It will then consist of one 30-foot bay for pneumatic moulding machinery, etc.; one 60-foot bay 200 feet long for large castings; two 40-foot bays 400 feet long, and one 25-foot bay to be used partly as a casting store and partly as a pattern store. Among the special appliances in use in the foundry may be mentioned the pneumatic moulding machine and the Piftin stoves for drying the moulds by means of a current of hot air. The next building is the machine shop, which contains also the smiths' shop, manufactured and general stores, erecting shop, and works-manager's office, and which when completed will have a frontage of 500 feet and a depth of 240 feet. It will consist of six-

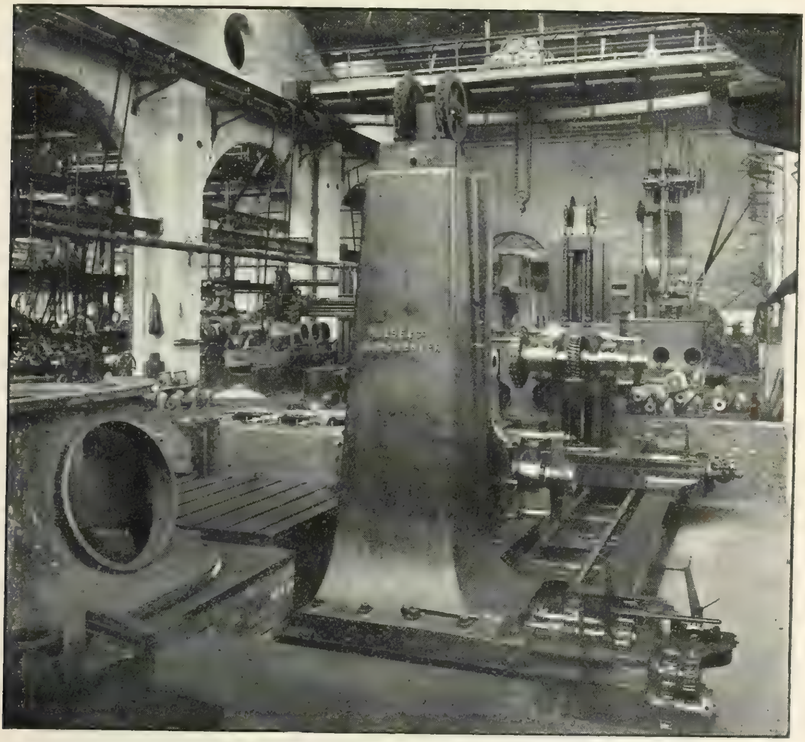


A BAY IN THE MACHINE SHOP



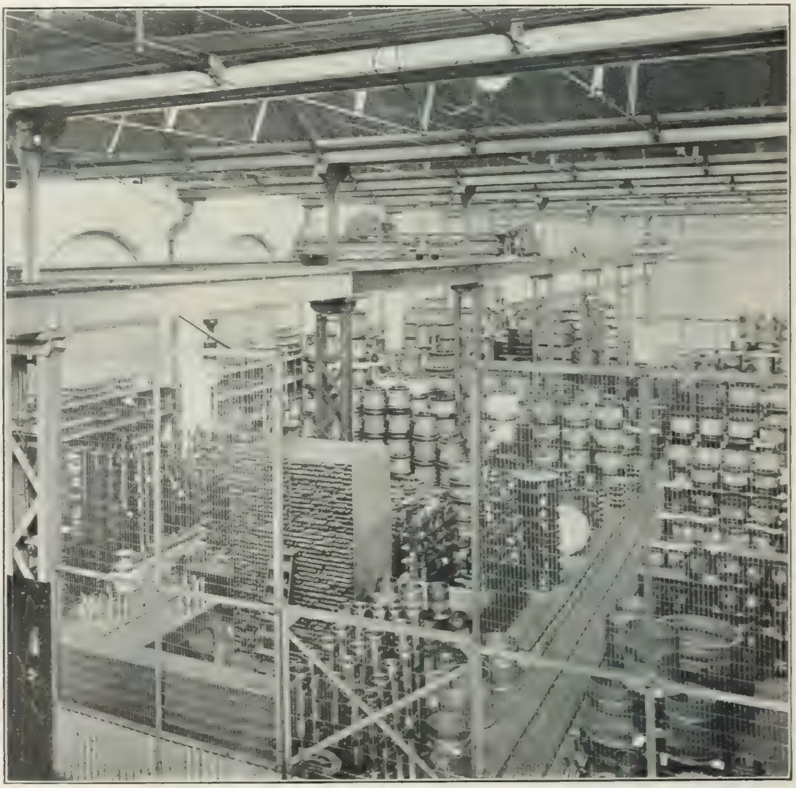
A PORTION OF THE ERECTING SHOP.

teen bays. Portions of Nos. 1 to 4 are already completed. No. 1 contains smiths' forges, and is separated from the remainder of the shop by a wall. The existing portions of Nos. 2 and 3 will contain crank-shaft lathes, and No. 4 a brass-finishers' shop, and the back portion will be devoted to the heaviest of the new tools. No. 5 is a new bay formed by covering an open alley between the existing buildings. It contains at present only a very massive 10 by 10 planer, made by the Niles Tool Company, under a temporary shed. No. 6 is a bay 40 feet wide containing the larger tools at present at work. Attention may be drawn to the large double-headed vertical milling machine which is illustrated on this page. This tool has two standards, each with a vertical travel of 6 feet, a traverse of 2 feet, and a longitudinal travel of 18 feet. The bay also contains two very fine vertical boring machines, horizontal boring machines, and planers of various sizes. Nos. 7, 8, 9, 10, and 11 are machine bays each 22 feet wide. They contain some fine crank-shaft lathes and boring mills, which, however, are to be shifted into the new bays when they are completed, as well

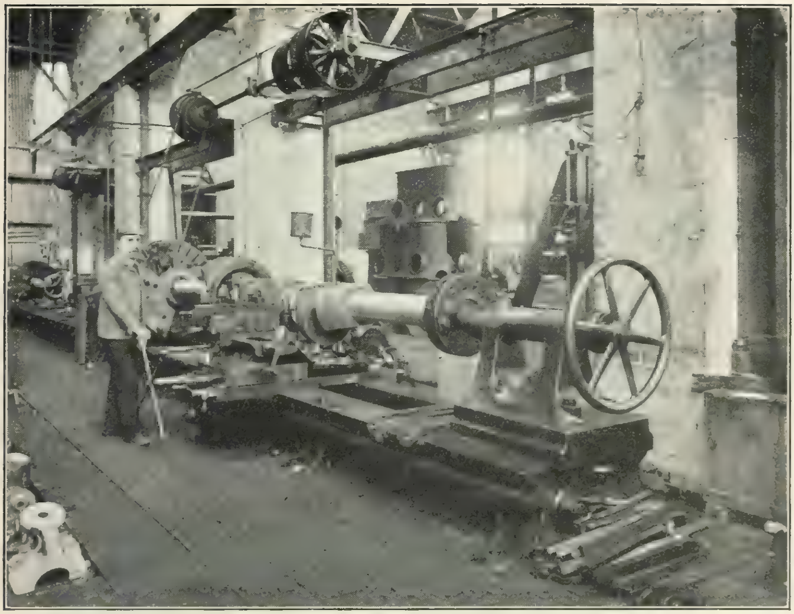


LARGE MILLING MACHINE IN THE MACHINE SHOPS OF THE RUGBY WORKS.

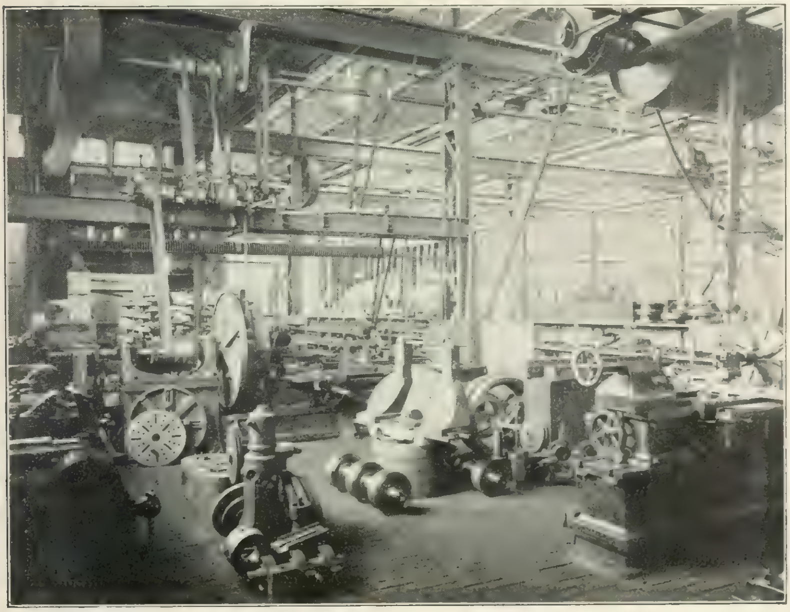
as smaller tools, including cylinder-boring lathes, shaping and slotting machines, radial and other drilling machines, etc. No. 12 is a fitting bay for putting together steam-gland boxes, connecting-rod brasses, and the few articles which are usually fitted before being sent into store. It is also used for assembling orders for spare parts previous to dispatch. Nos. 13 and 14 are the manufactured-stores bays, where all finished parts are brought first for inspection, and then for storage. Nos. 15 and 16 are the erecting-shop bays, each at present 240 feet deep and 40 feet wide. Both will be lengthened towards the south by 80 feet, and No. 16 will in the new part be increased in width to 60 feet, and will be about 12 feet higher than the remainder of the erecting shop, which is already higher than the rest of the machine shop. The latter, though forming part of the same building, is completely divided from the erecting shop by a wall. Adjoining the erecting shop but separated from it by an alley, which forms the loading-out place, is the packing and forwarding shop, and behind it, next



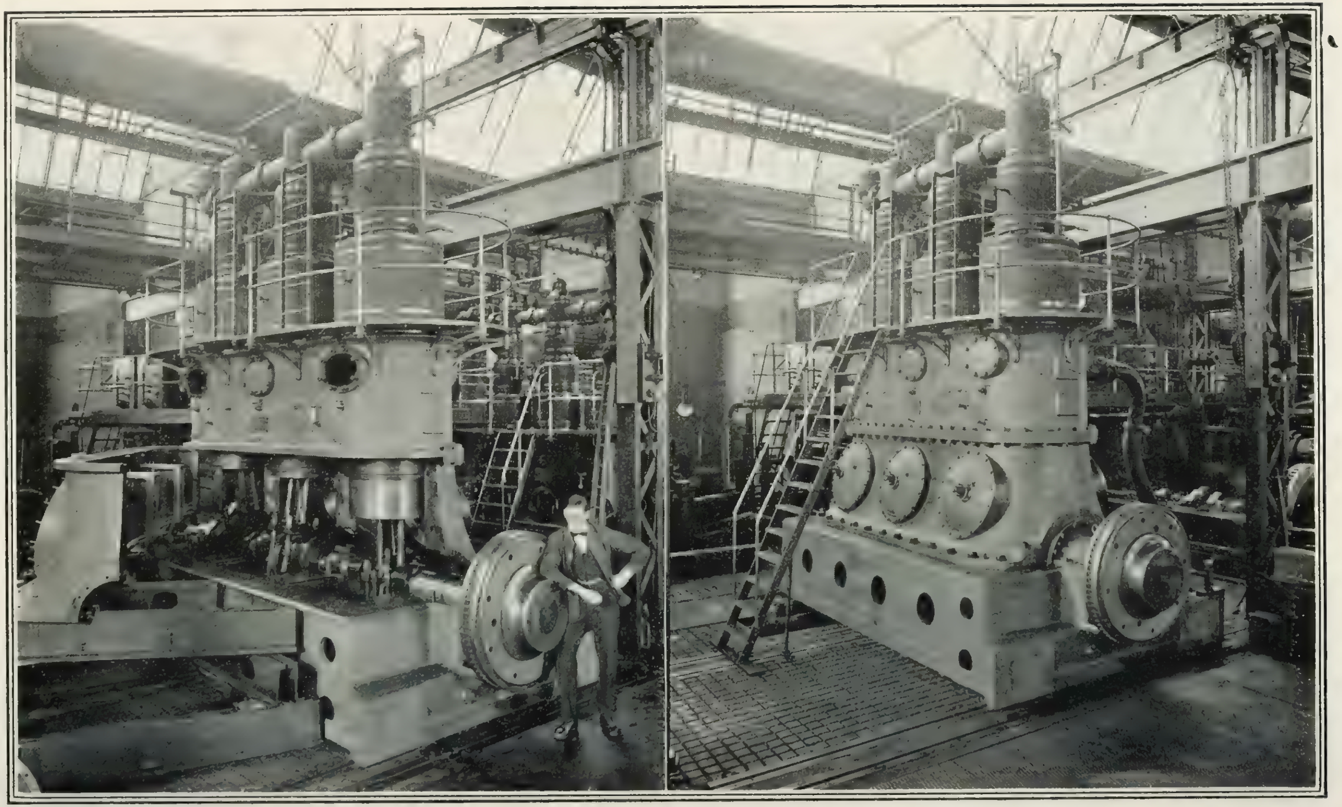
PART OF THE MANUFACTURED-STORES DEPARTMENT.



CRANK-SHAFT LATHE IN THE MACHINE SHOP.



A PORTION OF THE TOOL ROOM.

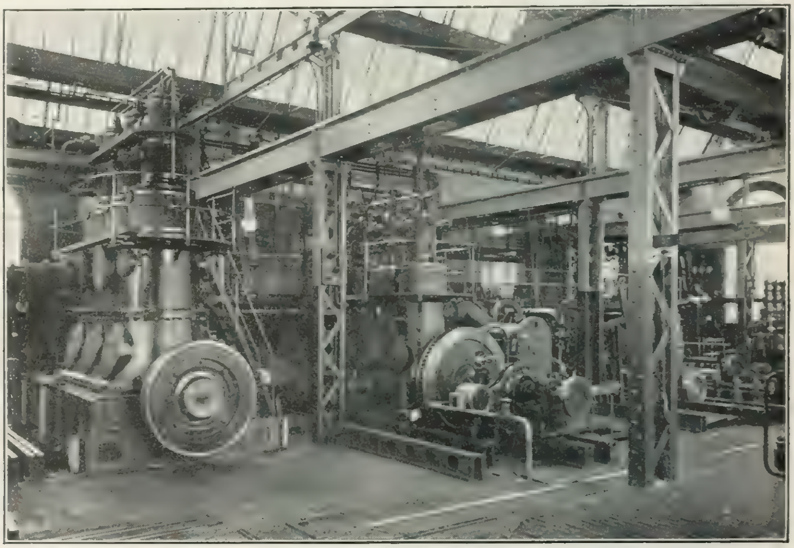


1,200-HORSE-POWER SET FOR THE LIVERPOOL TRAMS. THE VIEW ON THE LEFT SHOWS A PORTION OF THE CRANK-CHAMBER REMOVED, GIVING ACCESS TO THE CRANK-SHAFT, CONNECTING RODS, ETC.; IN THE RIGHT-HAND VIEW THE CRANK-CHAMBER IS SHOWN IN POSITION.

to the large extension of No. 16 bay, behind the forwarding department, will be placed the new power house, which will contain the engines and dynamos for lighting and for the electric driving of all the cranes, as well as of the machinery in the foundry and the new extensions of the machine shop. The present shop will continue to be driven temporarily by an existing engine and boiler situated in the front of the building. The remainder of this end of the shop is devoted to the tool and gauge department and the various stores. An overhead gallery contains the works-manager's offices. Adjoining the erecting shop on the east is the packing department and loading-out shed before referred to, which is commanded by a travelling crane and traversed by two lines of rails, one of standard gauge, communicating with the company's siding and running alongside a platform in the shed, and the other of 3-feet gauge for convenience in bringing goods alongside the trucks. The pattern shop forms one building with the packing department, and is adjacent to but separate from the pattern stores. The packing and pattern departments are kept entirely separate from the remainder of the works to minimise the danger from fire.

A siding from the railway of standard 4 feet 8½ inches gauge, with a large weighbridge at the entrance to the company's premises, runs along the front of the works direct to the foundry for the supply of raw materials. A similar and parallel line runs through the rear end of the foundry and machine and erecting shops, and the two are connected by lines passing, one down the west side of the foundry, and the other through the loading-out shed, with turntables at the angles. 3-feet and 18-inch tracks are also laid along this line, as well as through the front end of the machine and erecting shops, with connecting lines in all the bays. Branches of standard gauge also lead from the main siding into the erecting shop, testing department, and coal stores. The buildings are practically fire-proof, but very complete water service is laid throughout the works and offices.

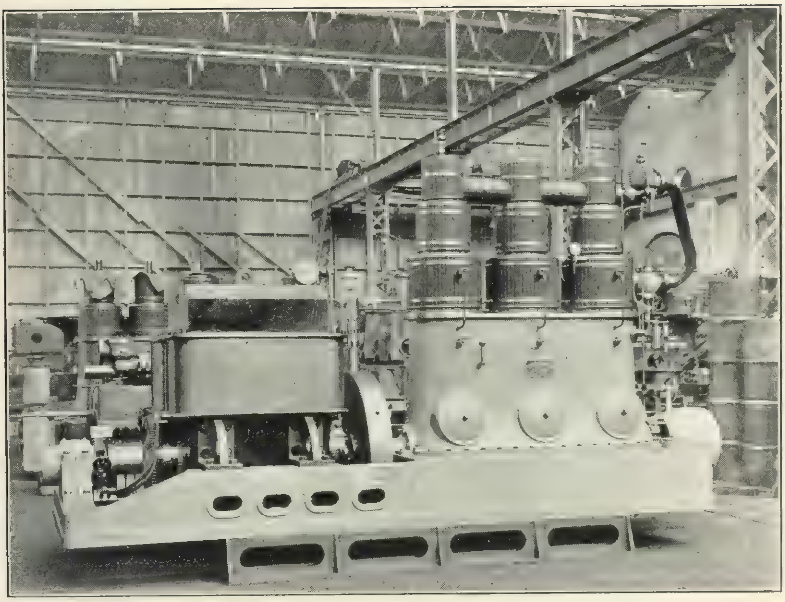
The testing department is separate from the rest of the works. The main building has five north-and-south bays commanded by electric and hand travellers. The floor is of blue brick with grooved girders upon which the engines are bolted, and pits are provided for the reception of flywheels or dynamos which project below the engine bed plates. Steam is supplied by four 300-horse-power Niclausse boilers made by the company, and there is a very complete system of swing pipes by which engines can be connected to the mains. The energy developed is either absorbed by means of resistances if the engine is driving a dynamo, or by a brake. One of Froude's water brakes, having a capacity of 700 horse power, is used for the larger engines. For making consumption tests the exhaust steam is condensed in surface condensers placed where required, and conveyed in pipes to a large tank standing upon a weigh-bridge and capable of holding some five tons of water. The arm of the weigh-bridge is placed in an office, in which are also collected the electrical measuring instruments and the bells for signalling to the attendants upon the engine under test, so that the complete control of a trial is concentrated in one spot. The system of weighing the exhaust steam eliminates all sources of error in measurement, since only the steam actually used by the engines is taken account of, and results are obtained far surpassing both in speed and accuracy anything possible under the more usual system of weighing or measuring the feed water.



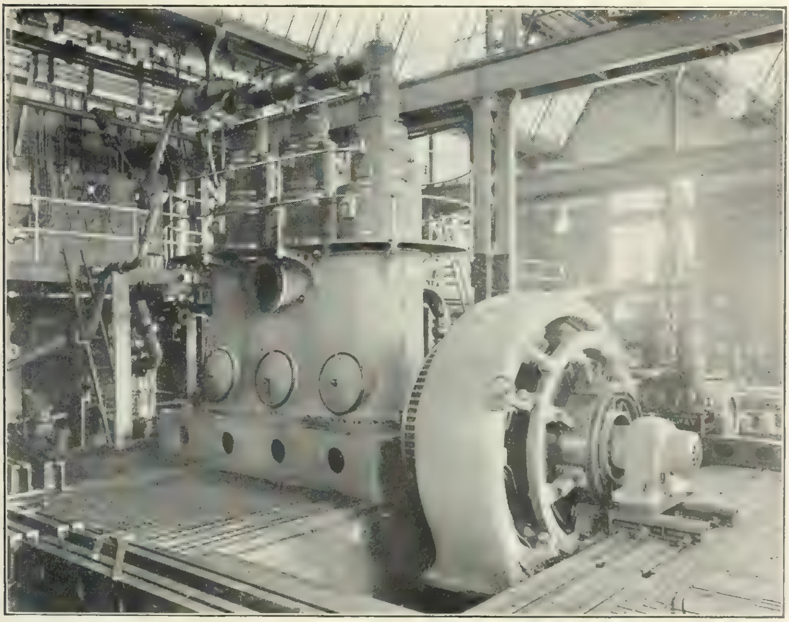
PORTION OF THE TESTING DEPARTMENT.

On the left is a 1,200-horse-power compound engine for the Liverpool Corporation Tramways, and in the centre a 575-indicated-horse-power engine for the City & South London Railway; this latter is coupled to a Froude hydraulic brake.

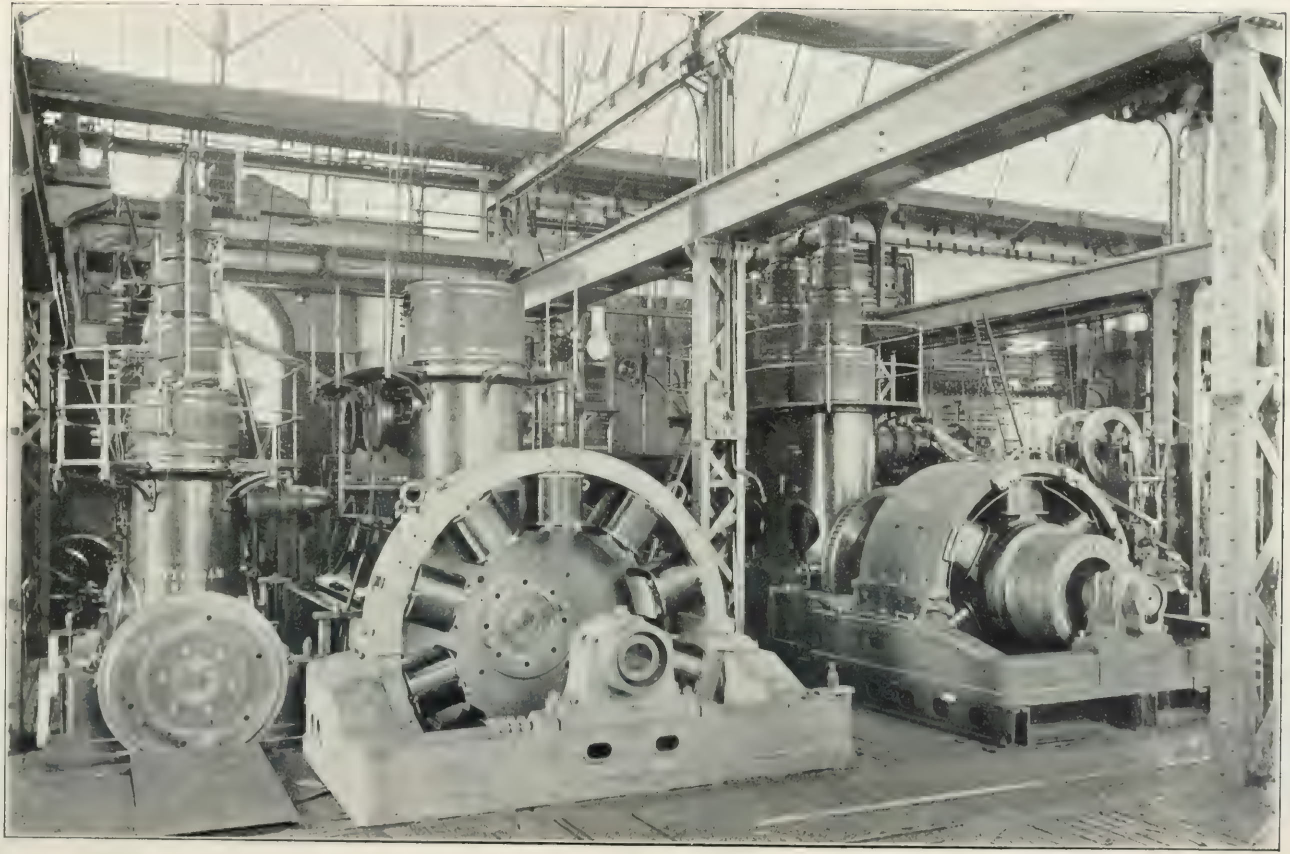
It has always been the policy of the company to standardise their products and to make all corresponding parts of the same size interchangeable. Even from the earliest days it was the custom to make "for stock," and when an order for a new size was received, to put in hand sufficient parts for half-a-dozen engines. This has been extended until there is now a large number of standard sizes ranging from 50 to 2,500 horse power, and a very complete and automatic



A PORTION OF THE ERECTING SHOP, SHOWING A 360-HORSE-POWER ENGINE AND DYNAMO FOR ONE OF THE LONDON STATIONS.



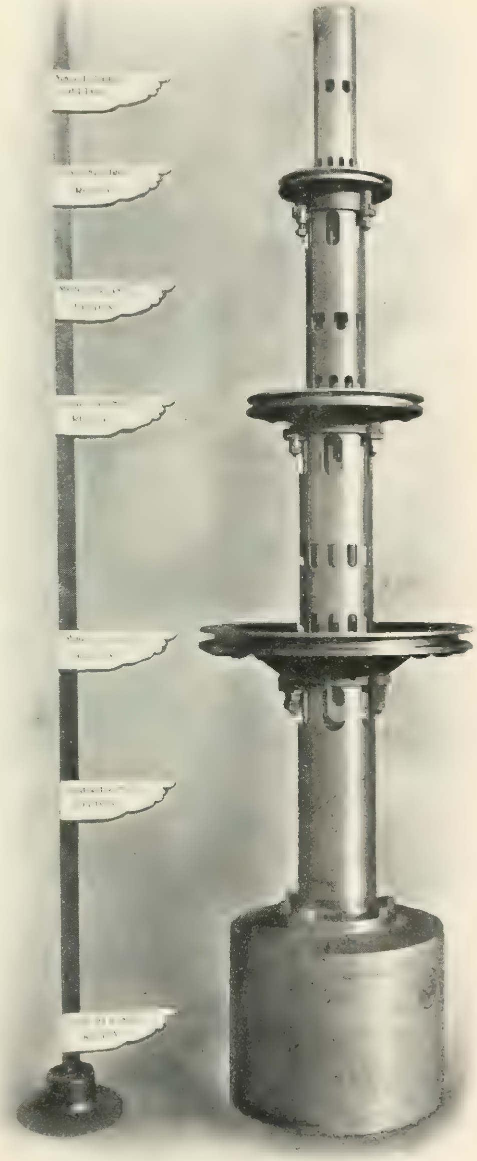
800-HORSE-POWER SET FOR PRESTON ELECTRIC-LIGHTING STATION UNDER TEST.



PORTION OF TESTING DEPARTMENT, SHOWING ENGINES OF 800 AND 700 HORSE POWER BEING GOT READY FOR TEST.

system by which the stock is kept up. The principal parts of each size are fixed and unchangeable, such as the crank shaft, bed-plate, connecting-rods, piston-rods, etc., but varying sizes of cylinders and pistons can be fitted to meet different conditions of steam pressure, etc. Care has been taken in arranging these variations to keep the total number of different sizes as small as possible by making each serve for more than one engine; for instance, the high-pressure piston rings of one engine will serve as the low-pressure rings of a smaller engine, and so on.

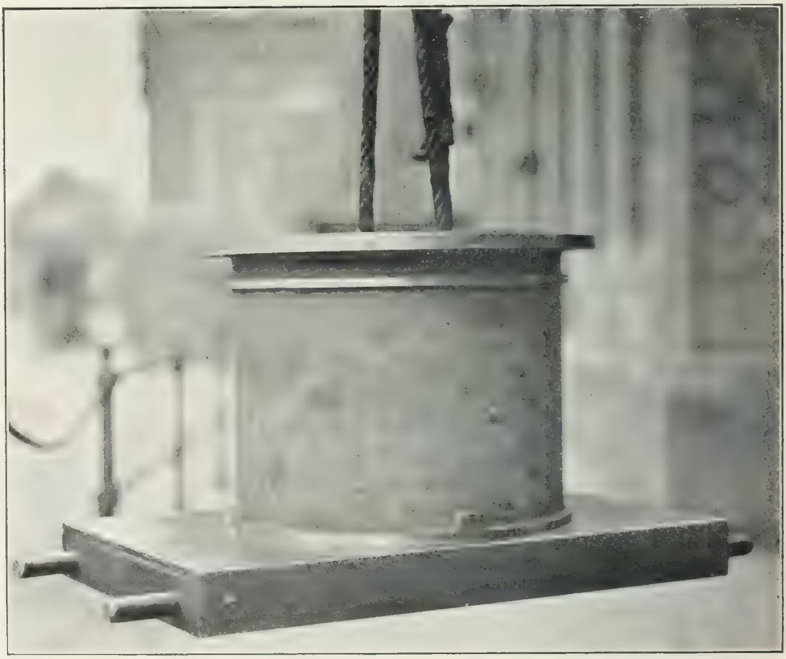
In order to insure the interchangeability aimed at, the different parts are invariably made in quantities, and an elaborate system of jigs, gauges, and templates is maintained and a special department forming part of the machine shop is set aside for their manufacture and storage. Here also all special tools, such as boring heads, etc., are made. This tool and template



A LINE OF MOVING PARTS, MADE AT DIFFERENT TIMES, PUT TOGETHER TO SHOW THE INTERCHANGEABILITY SECURED BY THE SYSTEM EMPLOYED.

department is provided with standard measuring instruments which have been compared with the standard yard and metre, for both systems of measurement are used. The gauges and tools are issued from this department to the workmen as required, and returned to it when done with.

All parts when completed are sent from the shops into the manufactured stores for inspection, and when passed are taken into stock. The manufactured-stores inspector is provided with a drawing of every piece, and on every dimension of each standard part certain limits of error only are allowed. If these limits are exceeded, or if the material or workmanship is considered defective, the part under examination is put aside with a report for the inspection of a director, whose decision is final.

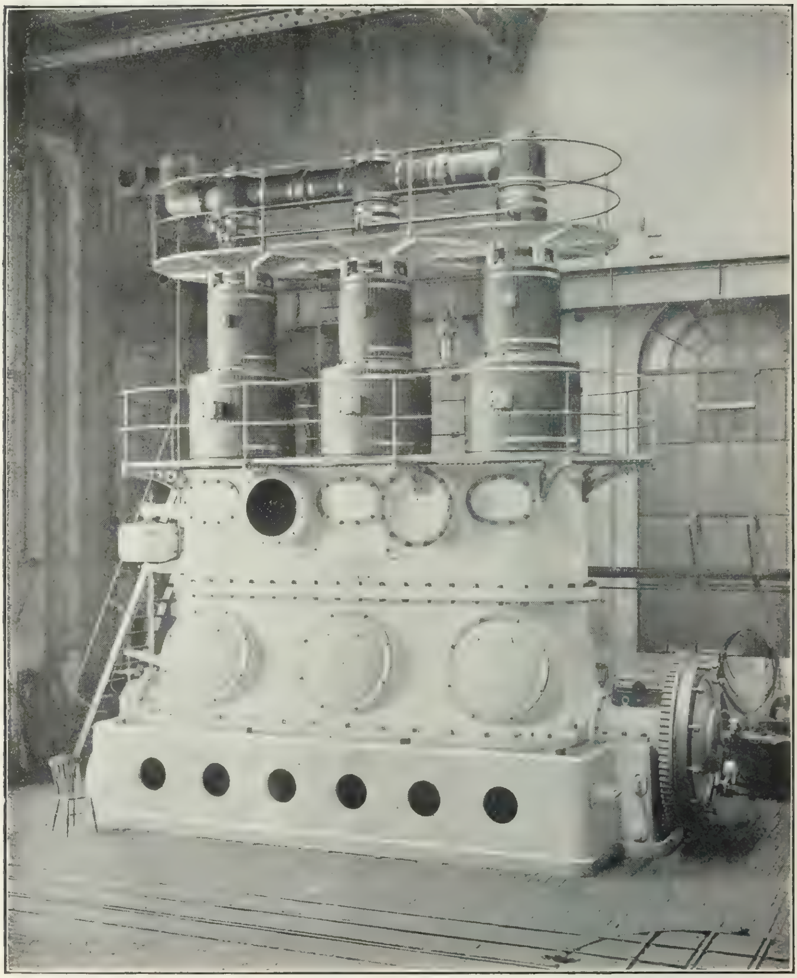


CYLINDER AND FACE PLATE SUSPENDED FROM A PLUG GAUGE, AS DESCRIBED JUST BELOW.

The following instance will enable an idea to be formed of the accuracy attained. The bore of a cylinder must not be less than standard in any case, nor greater by more than 0.0005 inch per inch of diameter in any part of the bore. Any cylinder which has passed the manufactured-stores test will, if inverted and placed upon a surface plate, allow the corresponding plug gauge, when inserted at the other end, to float upon the contained air—the cylinder being clean and dry. The gauge will spin quite easily in the cylinder but it will not sink for several hours, and if it be lifted by a crane the cylinder and the surface plate will go up with it. This also tests the accuracy of the facing on the cylinder head, which is depended upon in these engines for making the joint between one cylinder and the next, no jointing material whatever being used. The illustration on the opposite page shows the gauge suspended on the crane hook with the cylinder and surface plate hanging from it as described.

THE DRAWING OFFICE.

A certain minimum stock of each part of all sizes is aimed at, sufficient to provide for a predetermined number of engines, and when it falls below this, through the issue or appropriation of parts to engines on order, the stores inspector advises the works manager, who then passes an order to the works for a fresh batch to be put in hand. The work in the shops is therefore regulated by the actual quantity and sizes of the engines turned out, and a stock of complete engines is automatically provided. Upon an engine being ordered by a customer, a list of all its parts, standard or otherwise, is issued by the drawing office to the works manager, who draws the standard parts from the manufactured stores and puts in hand the non-standard parts, or, if they have to be obtained from outside firms, requisitions

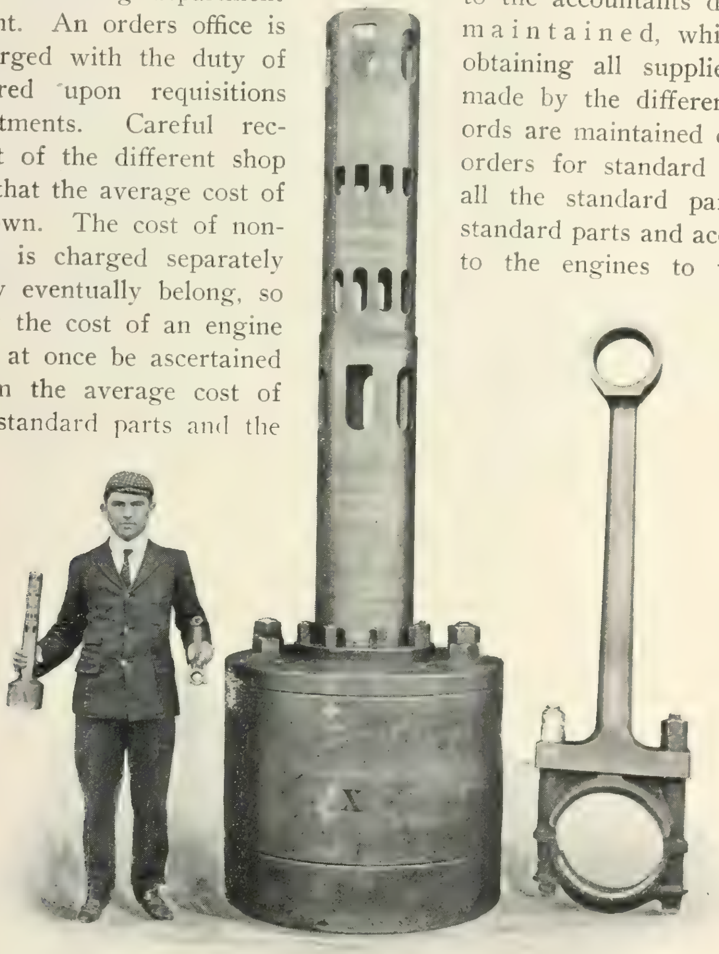


3,000-HORSE-POWER TRIPLE-EXPANSION ENGINE FOR THE PARIS EXPOSITION.

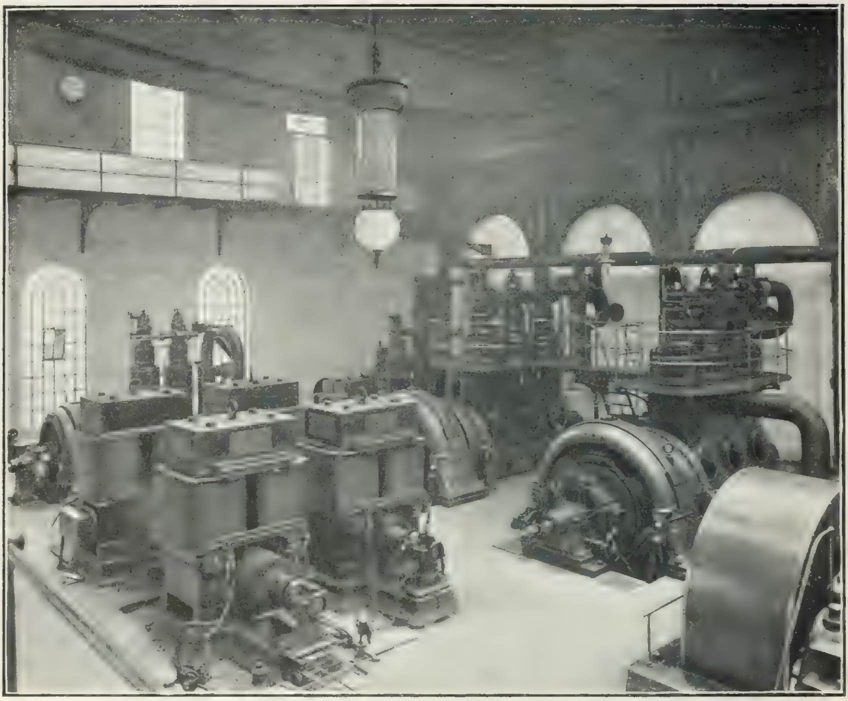
them from the orders department. This list forms also a permanent record of the engine and enables spare parts to be supplied promptly and accurately. Customers can be furnished with numbered sectional lithographs giving the names and numbers of all the parts of a Willans engine, and it is only necessary for them to state the number of the engine and the numbers of the parts required.

The general stores are separate from the manufactured stores, though under the control of the works manager. Goods are drawn from there by the various departments upon demand notes in the usual way. A minimum stock is also carried here, and replenished as required by requisitions from the works manager to the orders office, which obtains supplies from outside firms.

The commercial offices are kept quite distinct from the works and technical departments. All correspondence relating to orders is carried on by the estimating department under the control of the directors, and full particulars of orders obtained are issued by it to the drawing office which in turn gives instructions to the works as already described. Particulars of the contracts are also furnished by the estimating department to the accountants department. An orders office is maintained, which is charged with the duty of obtaining all supplies required upon requisitions made by the different departments. Careful records are maintained of the cost of the different shop orders for standard parts, so that the average cost of all the standard parts is known. The cost of non-standard parts and accessories is charged separately to the engines to which they eventually belong, so that the cost of an engine can at once be ascertained from the average cost of its standard parts and the



THE LARGEST AND THE SMALLEST HOLLOW PISTON-RODS AND CONNECTING-RODS MADE. The former are for an engine of 3,000 horse power, the latter for an engine of 3½ horse power.



GENERAL VIEW OF CITY AND SOUTH LONDON STATION, CONTAINING TWO 575-HORSE-POWER SETS AND ONE SMALLER ONE OF 250 HORSE POWER.

actual cost of its own special requirements. Where engines are made in large quantities, this system gives a perfectly accurate result and enables a very comprehensive and accurate idea to be formed of the cost of different pieces and processes.

In dealing with their workmen the company have adopted the premium system so far as is possible. Every standard part has a certain "reference rate" as a basis of payment, and if the workman produces it more cheaply the difference is divided in equal proportions between himself and the company. Certain regulations are in force for preventing the arbitrary cutting down of rates and so depriving the workman of his reward for increased skill, and the arrangement has been found to work satisfactorily to both sides. In the great engineers' strike of 1899, not a single man left the company's employment, and the only trouble experienced was from the difficulty of obtaining raw material. Most of the members of the staff received a contingent salary, dependent upon the general profits, in addition to their fixed stipend.

There is a voluntary sick club in the works, to which the company contribute annually a sum equal to the men's subscriptions. The surplus funds, including the company's donation, but less a certain amount to provide for current needs, are divided amongst the subscribers at the end of each year. The company have built a mess room, which is in charge of an attendant, who, in return for a small fixed wage, is allowed to supply meals at certain rates, and is also bound to cook the men's own provisions. Bath rooms and lavatories are provided in the basement of this building, which also serves for meetings, entertainments, etc.

The unoccupied portion of the company's premises is let as allotments to the workmen at a small rental, upon condition of its being resumed by the company should it be required for any other purpose.

Messrs. Willans & Robinson now employ about 950 men, or double the number employed at Thames Ditton just before the works were moved to Rugby in 1897, while the output has increased in an even greater proportion. In laying out the Rugby works, provision was made for engines of 800 horse power as a maximum size, but so rapidly have the sizes and demands grown, that more than thirty of 1,500 horse power have since been constructed, as well as several of 3,000 horse power, one of which was at work in the Paris Exhibition where it drove a dynamo for supplying light and power.

THE GOLD-DREDGING FIELDS OF EASTERN RUSSIA.

By C. W. Purington and J. B. Landfield, Jr.

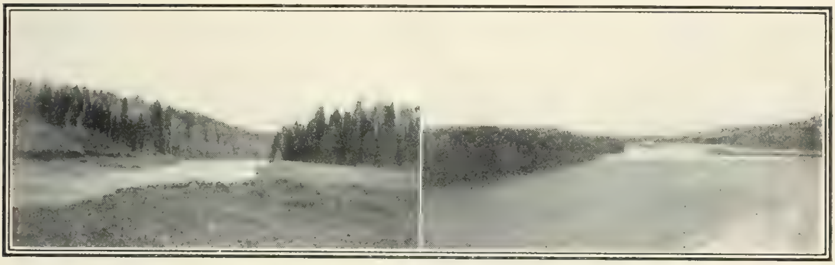
Russia is of so vast importance industrially, and above all as a field for engineering development, that accurate information as to its resources and possibilities is very valuable. We are particularly glad, therefore, to be able to supplement Mr. Purington's recent article on Siberian gold-mining with this authoritative sketch of the opportunities for gold dredging. It will be followed by a digest of the Russian mining law so far as this concerns the precious metals. The illustrations are from photographs by the authors.—The Editors.

Iron Monument Marking the Boundary between Europe and Asia on the Kooshva-Kungur Road.

GOLD-DREDGING enterprises, in whatever part of the world they were instituted, were for many years entirely unsuccessful. They labored under the disadvantages attendant upon all ventures of an entirely experimental character. As a result of the attempts to win the values from gold-bearing gravels so situated that the ordinary methods of placer-mining were unavailable, gold-dredging presented to the operator many difficulties of a novel character.

At the present time this form of placer mining may be said to have acquired the status of a permanent industry. The numerous conditions besides the actual tenor of the gravel in gold, which, as in other kinds of mining, must be taken into consideration in starting a dredging enterprise, are of a character so peculiar that they merit considerable notice. It has been the non-observance of the adverse conditions which has caused the downfall of so many promising schemes for dredging river-beds with the purpose of winning gold. On the other hand, it has been the concurrence of suitable natural features of the ground, together with the operation of machinery fitted to its peculiar surroundings, which has made gold dredging successful in the few localities now attaining prominence in this regard.

Although it is the purpose of this paper to call attention to the fields



ON THE LEFT IS A TYPICAL STREAM OF THE NORTHERN URAL. IN THE GRAVEL BAR OF THE LEFT BANK, GOLD MAY BE PANNED AT SURFACE. THE RIGHT-HAND VIEW IS A TYPICAL VALLEY OF THE STEPPES, SOUTHERN URAL, FILLED WITH AURIFEROUS SAND AND GRAVEL.

for gold-dredging lying in Eastern Russia and Siberia, it seems important that a brief review be given of the fields where the gold-dredging industry has attained some importance, in order that a better comprehension of the whole subject may be had. New Zealand furnishes the most successful examples of gold-dredging. Although the conditions for operating in the swift, short, New Zealand rivers can by no means be said to be ideal, the work is there conducted at a cost less than has so far been practicable in the United States. Dredging operations are also carried on successfully in Australia, though to a less extent. Alaska has been the seat of many attempts at gold-dredging, none of which, so far as known to the writers, have been successful. British Columbia has seen the installation of several dredge-boats, the operation of which has been more or less profitable. In various portions of northern South America attempts at gold-dredging have been made, which have been for the most part complete failures.

In the United States, dredging for gold is now carried on in California, Washington, Idaho, Montana, Colorado, Utah, and northern Georgia. The instances of failure have undoubtedly been much more numerous than those of success, but it may be said in general that the dredges operating in the rivers tributary to the Pacific Ocean have done the most satisfactory work, up to the present time, of any of the boats operated in the United States. The most notable instance of gold dredging, and that which best exhibits the growth of the industry in California, is the present activity in this line at Oroville, Butte County, on the Feather River. Within the space of eighteen months, the number of working dredges, each handling from eight to fifteen hundred cubic yards of gravel in twenty-four hours, has increased from five to twelve, several more boats are now building, and the available auriferous land has increased during that time from two to five times in price. The gold-dredging industry at Oroville is without doubt a financial success, as the increasing number of operations in the district round about goes to prove. On the other hand, in California itself, the most glaring failures have occasionally resulted from well-planned dredging operations. In the case of failure, too, machines and methods were employed almost precisely similar to those now in use at Oroville.

It is the opinion of the writers that natural conditions of a peculiar character are necessary as an accompaniment of the values in any locality where it is proposed to win gold by the method of dredging. Recent experience has proved that the greatest attention must be given to the topographic and geological conditions of the country in which the enterprise is to be inaugurated. Otherwise success in the operations is not to be looked for. For the sake of clearness, the following explanation of the necessary conditions for a dredging proposition is given.

Taking the country about Oroville as the best example in the United States, let the geological conditions be considered. To the north and east, the erosion of a vast extent of mountain country whose rocks are penetrated with gold-bearing veins has contributed, little by little through geologic ages, to the mass of detritus now occupying the bed of the Feather River. A wearing down of mountains, originally very much higher than at present, through a vast amount of time, has caused the formation of a valley of extraordinary width but of no great depth. The massing of stream-detritus is also responsible for a decrease in the gradient, and a slowing-down almost to a topographical equilibrium of the formerly swift current of the river. The stream, unable longer under these conditions to cut its way by virtue of the material which it carried in suspension, has for a long time been depositing its load, filling its wide valley with sand and gravel, together with the less destructible of the metallic particles, and notably, gold. Geologically speaking, the rate of deposition of the river's material may be said to be on the increase, and the current of the water, still of considerable velocity, to be gradually lessening in swiftness. Later in its geologic cycle the Feather River will doubtless assume, on a smaller scale, the present character of the Mississippi, forming ox-bow curves, cut-offs, and, as it were, losing its way among constantly shifting sand-bars.

The accompanying residual gold, as it travels to a greater and greater distance from its original source in the veins of the mountains, becomes more and more finely divided, even to microscopic dimensions, increases in purity, and the degree of evenness with which the particles are distributed in the gravel becomes a phenomenon of constantly increasing definiteness and importance.

Such a set of conditions as that obtaining on the Feather River is the exception rather than the rule in the western part of the United States, and even in California. The above explanation has been entered into in order to present in some measure the reasons why, on the California river referred to, the conditions are not only favorable but eminently suited to gold dredging. Shallow gravels, that is, those less than forty feet in depth, are an essential in dredging enterprises. Thus broad, rather than narrow gorge-like valleys, must be sought. Bedrock of a soft decomposed character, which can be easily cut into by the dipper or bucket of the dredge, is a necessity, since the placer gold, by virtue of its gravity, often sinks from one to two feet into the crevices of the rock underlying. It is hardly necessary to state that the amount of gold increases in geometrical ratio, the lower it lies in a given bed of gravel. Thus old, rather than young valleys, are favorable for dredging.

TYPICAL GRAVEL FLAT, NORTHERN URAL.

An additional reason of great weight why geologically old valleys should be looked for is that the size of boulders is greatly decreased, gravel becomes by long abrasion uniform in size, the angularity of the fragments disappears, and a bed of pebbles, rounded and easily handled, is the result.

The even distribution of the gold, which, as mentioned above, is an invariable accompaniment of old and wide valleys, is a point in favor of this sort of mining, looked at from the standpoint of a business enterprise. At the same time it is evident that the finely divided state in which such gold is found necessitates the highest skill in the recovering of it. For example, at Oroville, although some of the operators are saving gold the subdivision of whose particles is almost microscopic, it

ON THE LEFT IS AN AURIFEROUS GRAVEL BAR IN THE NORTHERN URAL; ON THE RIGHT, THE UI RIVER, SOUTHERN URAL.

is thought with good reason that a considerable percentage of the values is lost in the water used for washing. In this case the particles of gold are so exceedingly fine that they will not settle in still water in the space of several hours.

The consideration of the ordinary conditions which are looked to in connection with any mining enterprise, such as transportation, labor, source of power, supplies, etc., need not be entered into here. It has not been so much the failure to consider these as it has been the disregard of the natural conditions above set forth which has, in nine cases out of ten, caused the failure of dredging enterprises. This statement will be appreciated by all those who have been connected with the business of gold dredging, whether or not they have made a success of their undertaking.

While the mineral-bearing portions of the United States may, for the most part, be said to be geologically young, the vast gold-fields of central and northern Asia offer conditions which are exactly the opposite. It has been stated that broad shallow valleys, filled with gold-bearing gravel, such as that of the Feather River, are in the United States the exception rather than the rule. In the auriferous portions of central and west Siberia and eastern Russia, such valleys are decidedly the rule. There, as for example in the Ural mountains, an amount of time inconceivably long has elapsed since the commencement of the erosion of the present drainage systems. Even the Altai, a mountain-system in which certain peaks exceed ten thousand feet in height, shows the marks, by the dome-like character of its summits, the great width of the intervening valleys, and the uniform breadth of the streams for long distances, of an exceedingly old mountain region. Perhaps more extraordinary still is the uniform topographic character of Siberia over its entire east and west extent. The greater part of it may be best described as a gigantic rolling country, with rounded hills and mountains and broad flat valleys.

Especially in the portion of eastern Russia known as the Ural region do the above-described conditions obtain in the completeness of their development. The Ural mountains are, in fact, for the most part low, rounded hills. In the vicinity of the main line of the Trans-Siberian railroad there are no peaks which exceed 3,500 feet in height, while the highest points in the Ural mountains do not exceed 6,000 feet above the sea. Immense areas within the limits of this region are almost level, or if they possess any elevations, they form only a rolling prairie-like topography. High mountains have undoubtedly occupied the areas now presenting a plane surface to the eye, but these mountains have been eroded, leaving nothing but their indestructible *débris* behind, consisting for the most part of quartz pebbles with the accompanying rolled particles of gold. Streams which were once torrents now wind about in broad flat valleys filled with gravel. Often it is the case that even the streams have ceased to flow, and their former valleys are now occupied by shallow lakes, or bogs full of standing water. Peat deposits are not uncommonly found covering the surface of the bogs, a result, doubtless, of the successive quick annual growth and decay of the luxuriant vegetation which prevails. From latitude fifty to sixty north along both the east and west slopes of the Ural divide are found the winding rivers and their tributaries, of the character described, in extraordinary abundance. They are frequently bordered by immense swamps, having a width of from one-half mile to five miles. In traveling through the swamps one frequently comes upon crescent-shaped lagoons, far away from the present bed of the river, but which represent old channels through which the river formerly made its way. These are precisely analogous in origin to the lagoons formed along the Mississippi, by its "cut-offs."

DREDGING GROUND, NORTHERN URAL, SHOWING DEPTH OF TURF COVERING.

The importance of the existence of streams and swamp conditions of this character, considered from an economic standpoint, lies in the fact that the gravel beds underlying the areas in question are the result of the wearing-down, through geologic ages, of mountains containing auriferous veins. That, further, the rocks composing the mountains are for the most part slates and metamorphic schists, standing on edge, from their position and lithological character extremely subject to decay. That, finally, the auriferous gravel deposits underlying the rivers and swamps, though wide, are comparatively shallow, and are underlain by a floor of the same decayed slates and schists which compose the mountains. Thus it will be seen that the conditions requisite for dredging operations, as outlined previously in this paper, are, in the Ural region, of wide-spread occurrrence.

TESTING GOLD-DREDGING GROUND BY PIT SINKING, NORTHERN URAL.

Gold placers have been worked in the Ural and in Siberia for many years, but with rare exceptions no attempts have been made to extract gold from the gravels lying below the level of the surface water. Ill-considered attempts at dredging have been made in a few instances on the tributaries of the Amoor river in east Siberia. These were failures, principally on account of the shortness of season and the distance from repair-shops. In the Ural, peasant operators have long obtained gold and platinum from the rivers by the practice of "boat-shovelling," a method formerly used to some extent in the south-eastern part of the United States. This method, however, which employs no machinery more elaborate than a hand-windlass, is necessarily limited in capacity. Within two years dredges of the New Zealand and American types have been installed in the Mariinsk district of west Siberia. Reports from the New Zealand dredge, the only one in operation during the season of 1900, leave no question as to its complete success.

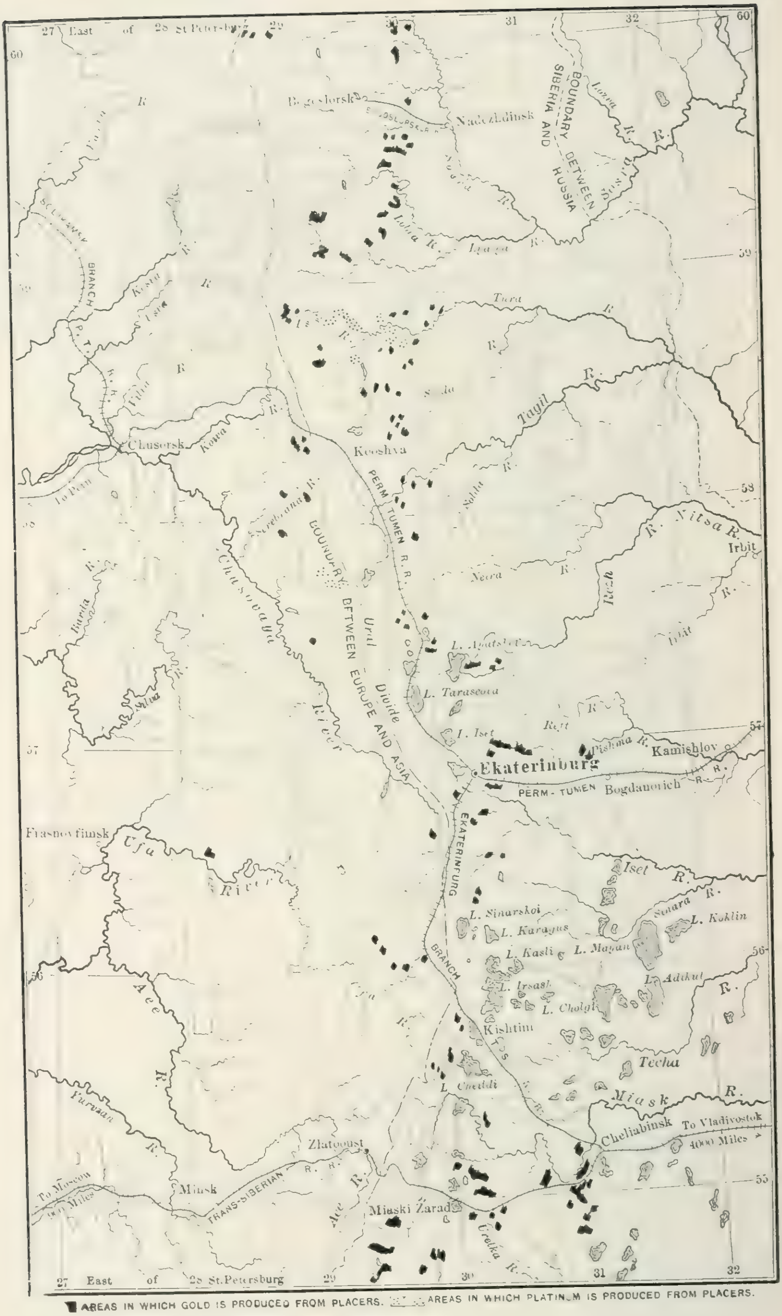
TARTARS, KOCHKA GOLD FIELDS.

Already, as a result of the reports of the profitable dredging in other portions of the world, much testing of the Ural and Siberian dredging ground has been done. In a typical area in the Ural, where tests were made under the direction of the writers, the conditions of gravel beds covered by swamp were found with an extraordinary degree of uniformity along the stream for a distance of thirty miles. The stream wound through the flats, its width varying from seventy-five to one hundred and fifty feet. The average width of the gravel bed was two thousand feet, its depth fifteen feet to bed rock, and it was covered by a layer of loam five feet in thickness. The bed-rock, a chloritic schist, was soft, and could be easily dug into with a pick to the depth of five feet. The average size of the rounded pebbles taken from the pits was not above four inches. An extraordinary uniformity of conditions was found to exist in portions of the area several miles apart.

Gold was found throughout the whole mass of gravel at the rate of twenty cents to the cubic yard of gravel. "Colors" of gold could be panned in the gravel taken from the river-bank, it being estimated that this surface material ran about three cents to the cubic yard.

The size and shape of the particles of gold from this river, as well as from many others tested, are very similar to those obtained in the dredging operations on the Feather River in California. A timber growth, birch, spruce, and fir, had originally covered the gravel flats, but had been partially cleared away by the peasants for the purpose of raising hay. In consequence, broad meadows bounded the river on both sides for long distances. An evidence of the wide extent of the conditions found along this stream is the fact that at a distance of three hundred miles to the south

A FOREST GUARD, NORTHERN URAL.



MAP OF A PORTION OF THE URAL REGION, EASTERN RUSSIA.

Showing the extensive development of drainage systems.

of it, another deposit was examined, and almost the same conditions were found to obtain. The principal difference was that, the southern area being in the steppe region, no timber covered the ground. As to the tenor of the river gravels in gold, it is not unlikely that many of these vast flats contain gold in too small quantity to be worked with payable results. The cost of gold dredging in the Ural and in the accessible portions of west Siberia should not exceed six cents per cubic yard of material handled. This being the case, it cannot be doubted that there exists in the territory in question a large amount of payably auriferous dredging ground. The map accompanying this paper gives an idea of the wide development of river systems in the Ural alone.

URAL LABORERS.

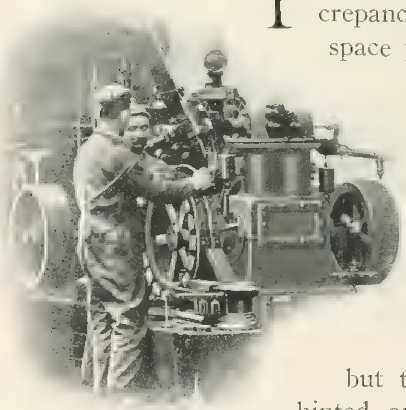
A working season of six months may always be counted on in those portions of Siberia west of the Yenesei river, whose northern limit may be roughly taken as an imaginary line drawn parallel to, and two hundred miles to the north of, the Trans-Siberian railway.

The region adjacent to the Ural is the most attractive field, considered from the gold-dredging standpoint. Its accessibility to railway transportation, the abundance and cheapness of labor, and the existence in it of machine shops of a high order of excellence, are all points which the prospective operator would be apt to consider favorably. In west Siberia, it is not likely that the deposits capable of being worked by dredges will be found to be any richer than those of the Ural, but the drainage areas are greater, the valleys wider, and the streams longer, consequently the total available area should be considerably more extensive.

A PROJECT FOR A BUREAU OF ENGINEERING DATA.

By Leicester Allen.

Mr. Allen in his argument does not at all intend to ignore what is being done nationally in Britain, by various Continental governments, and to some extent by the United States, in the way of establishing bureaus of engineering data; he merely pleads for the extension of the movement, particularly in the field of dynamic engineering. Static work has long had such aid through the establishment of comprehensive surveys—geologic, topographic, hydrographic—through astronomical observations, and weather bureaus. Mr. Allen proposes that the enormous growth in the importance of power engineering should be recognised by corresponding national—or international—assistance in those matters which are manifestly beyond the power of individuals or societies.—The Editors.



IN a former article I set forth some of the discrepancies of precept in machine designing, space permitting the presentation of a summarized view only, not an exhaustive one, of the conflicts of opinion on the theoretical points, the discrepancies in data, and the compromises which designers are forced to make in a single department of mechanical design—steam engineering. The nature of the remedy was indicated at the end of that article, but the means of securing it was merely hinted, and is, I think, of sufficient importance to merit further discussion.

The conflicts, discrepancies, and compromises are by no means confined to any one department of engineering, but are distributed over the whole field, some departments showing more than others, but none being wholly exempt. In hydraulic engineering, for example, there are more than a score of different formulæ for the computation of thickness of cast-iron pipes. In 1894 the American Society of Mechanical Engineers, and Master Steam and Hot Water Fitters' Association, through committees appointed by each, acting conjointly, agreed upon standard sizes and dimensions for pipe flanges, the want of uniformity being a source of great annoyance particularly to heating and ventilating engineers. But within two years I have heard complaints that this standard is not universally followed. The sizes of wrought-iron pipes have been standardized by some of the leading manufacturers, but there are still iron pipes sold which vary enough from the standard to exact too much labor in cutting threads corresponding with standard fittings, or to compel deficient threads. There is still a difference of opinion and practice on the subject of screw-threads, owing to the difficulties in applying a refined standard like that worked out by Mr. William Sellers, recommended by the Franklin Institute in 1864, adopted since by the United States army and navy departments, and now known as the United States standard The desire to adhere to this standard has, however, been so strong as to give rise to limit gauges which indicate whether the iron designed to be screw-threaded is larger or smaller than a certain allowable variation from the correct size necessary for cutting a perfect screw-thread in accordance with this standard.

The opinion that the straining of a metal piece of machinery merely beyond one of its elastic limits does not injure it, but that injury results from straining beyond its elastic limit of tension and that of compression alternately and repeatedly, has much experimental evidence to sustain it; but the subject of elastic limits and their relation to endurance under dead and live loads, loads suddenly applied and removed, and shocks, needs further and exhaustive investigation till such definite and uniform results are obtained as will establish laws of endurance beyond any question. This is not to withhold full credit for the valuable work already done by experimenters of highest ability, but to demand much more work on the same lines. Facts of such fundamental importance must be made the subject of so much corroborative experiment that their acceptance is as compulsory as assent to the law of falling bodies, or the conservation of energy.

In casting and forging, though notable advances have been latterly made these very advances indicate how much yet remains undetermined. In tool steels and their management there is yet much to be learned. Of the innumerable possible alloys, there are probably not more than two hundred, taking all the arts of construction and manufacture into consideration, which have been investigated and found valuable and useful. That this field of discovery is exhausted, or even nearly exhausted, or that fifty years of thoroughly organized and systematic laboratory work in this one line of investigation would discover all there is in it, who that has given close thought to the subject can believe? The work that has brought to light the now known useful alloys has been, to say the least, desultory: what might not be expected from systematic effort of able investigators solely directed to discovery and investigation of alloys, in a well equipped laboratory fitted up for this single end? The announcement of one of the latest of possible metallic combinations, magnalium, even if time shall prove that it does not possess all the valuable properties at present claimed for it, indicates what may be reasonably expected from systematic work in this broad field of study.

The study of building materials and cements, and also materials for paving streets, is far from complete. The preservation of metal structures is a problem as yet only very partially solved. In heating and ventilation there are yet many moot questions. In gas engineering there remains open debate upon many important points of vital and fundamental interest. Discussions and disputes upon undecided points are found in almost every issue of publications devoted to electrical engineering. In mining and processes for reduction of ores, invention still proves that we are very far from having reached a finality, and the chemistry of the subject is in an unsettled state on some important technical points. Machinists are still at variance, both in theory and practice, as to the best proportions of the teeth of gear wheels. They are also not agreed as to whether involute or cycloidal teeth are the better. The uncertainty of factors which enter into formulæ for computing the strength of the teeth of wheels gives rise to much divergence in the formulæ themselves. The highest speed at which gearing ought to be run is also in dispute.

Lubrication, though it has been much studied, needs further investigation; the results of modern experiments not only give different co-efficients of friction from those once accepted as valid, but the relations of speed to friction as laid down in some modern text-books and books of reference should be absolutely confirmed for practical and ordinary conditions, or disproved by revised and prolonged experimental investigation. The whole subject of friction and lubrication is marked by difference of opinion and doubt.

Without dwelling longer upon the need of further investigation, engineers will generally concur in the opinion that in all branches of mechanical engineering and in many lines of civil engineering there remain far too many open questions to be answered, not by reference to fixed rules of practice, but according to the best judgment of the individual engineer.

Not only a system of organized investigation is needed, but a recognized, authoritative, permanent method of arbitration whose decisions shall be in the nature of those rendered by a highest court and rank first in the minds of the engineering world. In other words, a perfectly equipped and systematized working bureau of engineering data is needed, whose functions should embrace the examination, affirmation, or negation of existing data, going over the entire field and instituting investigation for the purpose of supplying such additional facts and materials as may be found valuable in their application to practice. Could this be effected, long strides toward uniformity in practice would be made in a few years. Such an institution could very properly demand and receive the necessary funds for its foundation and support from the State. It would very much more than return its cost to the commercial interests of any industrial nation that might initiate it. But, as the results of such work could not be confined to the commerce of any single country, the institution ought to be international.

The world has lately been dazzled by the more than princely gifts of Andrew Carnegie for the founding of public institutions. This gentleman has acquired a collossal fortune in the prosecution of industries whose very existence, as well as marvellous development, is directly dependent upon the engineering arts. Since this development has benefited the nation as much as it has the philanthropic and generous organizer, no one could justly cavil were he to retain in his own possession the vast wealth he has acquired; but as he has announced his intention of distributing his fortune for the public benefit, during his lifetime, it may well be suggested that the foundation and endowment of such an institution as is herein proposed (without any disparagement, but rather with warm approval of what he has already done) would be of far greater and more universal benefit. An international bureau of engineering data would be a powerful educational influence throughout the entire civilized world.

That most likely to impair or defeat the usefulness of such a bureau is lack of adequate appreciation of its needs, and of the cost of supplying them in its initiation, together with ample provision for its efficient conduct for an indefinite period. If the views regarding the present condition of data available to engineering arts expressed in this article are correct, satisfactory approximation to uniform standard formulæ will be the work of years; and as engineering develops on new lines, as, for example, electrical engineering has done during the last twenty-five years, new and reliable data will be required. The industrial history of the world indicates advance, not retreat. There is no reason to believe that the century just begun will prove in this respect any exception to its predecessor.

It may well be that any attempt at an impromptu enumeration of the apparatus of a complete outfit will fail to include important particulars, but a general outline may be hazarded.

First, the outfit should include an analytical and experimental chemical laboratory of the most complete character, the experimental work for metallurgic investigations to be conducted on a fairly large practical scale. To do this, a part of the laboratory should comprise a practical foundry with a fairly good-sized cupola and furnaces for alloys wherein metals can be mixed and fused in practical quantities, in the study of mixtures, after the chemical composition of each of the materials used for experiment has been accurately determined. Physical qualities of resulting mixtures should be exhaustively investigated in a testing laboratory provided with appliances of the most approved kinds for conducting tests of all kinds of materials used in the mechanical arts, or proposed for such use. The question of resistance to oxidation or corrosion by external influences should, of course, be referred back to the chemical laboratory, to which, also, the protection of materials from injury by chemical agencies would also be properly referred.

The testing-laboratory apparatus should be of a size or sizes such as may be needed to test data for materials used in actual manufacture, from a silk filament up to a main shaft of a steam engine or a large girder. In short, it should be capable of testing the strength of anything proposed for test.

An ample physical laboratory of the most comprehensive character should afford the necessary facilities for examination and re-examination of all questions in dispute with reference to physical conditions in the operation of motors and other machines, and the effects upon durability produced by physical changes as the result of continued use. These studies should be pursued with motors operating under actual conditions of service, favorable and unfavorable, and there should be no stint in the outfit. Funds should be available for the purchase, erection, and operation of any motor or machine of sufficient importance to be made a subject of study. Here the action of the walls of steam cylinders upon steam during induction, expansion, and exhaust, and the effect of clearance partly or wholly filled to initial pressure, and similar points in steam-engine practice yet in dispute, should be finally settled, as well as the displacement from the adiabatic of curves of actual expansion under a sufficient range of varying practical conditions. This laboratory should also contain apparatus for an elaborate and exhaustive study of friction at rest and at different velocities of rubbing surfaces, of all lubricants, and of methods of applying them.

There should be a specially arranged and equipped laboratory for the study of practical hydraulics and another for pneumatics, in which a revision of the data in these departments should be made with the utmost refinement that can be applied in actual practice.

An electrical laboratory would be a *sine qua non,* and it should be fitted to deal with any possible question upon which electrical engineers now differ, or which may arise in future practice.

The bureau should have as complete a library of all works relating to engineering as can be collected.

Lastly, it should have a department of publication from which should issue periodical reports of all the work done, the methods employed, the considerations which influence the choice of methods, and the results attained, so that the work accomplished may be continuously exposed to criticism and discussion of the methods, results, and quantity performed.

The usual methods of conducting the finances of large educational institutions would apply to an institution of this kind. The corps of investigators should be selected from men of the highest ability and they should receive salaries that would insure life service. They should be furnished with assistants in such numbers as the efficient work of the institution might demand, for the performance of such manual work as would be required. The buildings needed with the offices should not lack architectural fitness with proper regard for style in their ornamental features, and suitable consideration of site with relation to lines of freight traffic as a convenience in the handling of machines and materials in transportation to and from the institution.

Such an institution, located in any land, would produce the same excellent results; but the question of location, if it were founded and endowed as an international bureau, would probably give rise to prolonged debate. If, however, the munificence of some private individual should give it to the world, no difficulty of this sort would arise. He could select the country he wished thus to honor with a gift to the entire world, acquire a fame as lasting as that of Ptolemy, and erect a monument to the highest spirit of this wonderful age as remarkable, if not as durable, as the pyramids. Its value would be inestimable, and, as compared with current independent and sporadic investigations, its work—persistent, logical, and thorough—would command respect and bear an authority higher than any other on the facts with which it would concern itself.

THE DESIGN AND ACTION OF THE ROTARY CONVERTER.

By David B. Rushmore.

Electric power and apparatus for the utilisation of electric power have taken their place among the most useful agencies employed by mechanical and mining engineers, and with the opportunity to use these media comes the necessity for a general understanding of their nature and functions. It is to the useful work of explaining one of the most interesting pieces of intermediary electrical apparatus that Mr. Rushmore devotes himself in the following paper. A second article will discuss the operation of the converter.—THE EDITORS.

CONTINUED extension of electricity to wider fields of usefulness brings also the necessity for better acquaintance, on the part of those not strictly electrical engineers, with the applications and properties of the various kinds of apparatus in which this form of energy is transformed and utilized. The understanding desired is not that presented in a popular form for the lay mind, nor is it of the purely theoretical character suited to those engaged in the design and manufacture of electrical machinery. It should rather be addressed to the buyer and the user. The mechanical or mining engineer has a given problem and he needs to know the facts which will help toward its solution. He is especially concerned with reliability of operation; with cost of installation, of operation, maintenance, and repair; with the depreciation, and with the danger to life. As a rule he is not especially concerned with any of the constants which enter into the design, unless it relates to the time element in operation. It is, however, not always possible to discover, under the usual conditions of commercial testing, just what the conditions of operation of a commutating machine will be, after it has been running for a considerable period of time. It is with the endeavor to bring before this class of professional and business men the principles of the rotary converter and the facts of interest in connection therewith that the present paper is written.

The areas of distribution from power stations have been increasing rapidly, and where it is desirable to utilize the electrical energy in the form of continuous currents the amount of copper necessary for satisfactory operation has required so great an investment that a change in the method of transmission has been found expedient. One of the principal fields of application of continuous currents is to railway work. For some time the length of feeders did not in many cases exceed five miles and generation of continuous currents was best. When, owing to new developments or extensions of old lines, the distances from the power house were increased, boosters were introduced to raise the voltage on the long lines, and in some instances storage batteries were installed at the distant points. The storage batteries received power at moments of light load and kept up the voltage at times when heavy loads were thrown on the line. This solution gives a better station load curve, a higher efficiency, and more satisfactory electrical operation. But a limit in distance is soon reached here, and we come to the next and present solution—the use of the rotary converter in connection with alternating-current transmission. In some instances where most of the power is used within the prescribed radius, it is preferable to generate it in the form of continuous currents and to convert and transmit in the form of alternating currents only that part needed for the few outlying lines. In some stations what are known as double-current generators have been installed. These give electrical energy in the form of continuous and alternating current at the same time and in any desired proportion.

Large units of the capacity now specified for modern power houses are preferably made in the form of inductor or revolving-field alternators. These are cheaper to build, more easily repaired, less likely to get out of order, and should have longer life than large continuous-current generators. In many instances the necessary high voltage for transmission may be taken directly from the machine, and this is often done where the desired pressure does not exceed 12,000 volts. At a higher pressure, the necessary insulation for the armature conductors so reduces the output of the machine that transformers are placed between the generator and line, to step up the voltage to that desired for transmission. When it is considered that the cost of copper for the line varies inversely as the square of the voltage, it is seen at once how desirable it is to transmit the energy at as high a potential as possible. If the conductors are in the form of underground cables, the cost of necessary outside insulation increases rapidly with the voltage so that here a compromise must be effected.

When the energy is transmitted in the form of alternating currents, rotary-converter sub-stations are placed at intervals along the line, whence the power is distributed as continuous current.

Another field in which continuous currents are exclusively used is that of electrolytic work. While alternating currents may be used when heat alone is desired, continuous currents are necessary for electrolytic action. If all the power generated is to be used for this kind of work, it may be desirable to install continuous-current generators. Where, however, the load is of a mixed character, and a considerable portion may be used for transmission, the generation in the form of alternating currents and the use of the rotary converter offers the best solution. Rotary converters are also largely used in lighting work, in stations where it is desirable to run continuous-current generators in parallel with alternators, and in conjunction with alternating-current systems where it is desirable to use storage batteries.

The Rotary Converter:—Outwardly the mechanical appearance of a rotary converter is very much like that of a continuous-current generator to which has been added a set of collector rings. The use of the rotary converter (or simply "converter") is to transform electrical energy from the form of alternating currents to that of continuous currents or *vice versa*. In reality it may be considered to combine two separate functions, in which form it often appears, that of an alternating-current synchronous motor driving a continuous-current generator. In the converter there is but one field and one armature winding. The field does not differ materially from that of a continuous-current generator of the same frequency except in the proportion which it bears in size to the rest of the machine. The armature is usually of the parallel-wound type in which there are as many circuits as there are poles. The alternating-current leads are brought out at one end and the commutator connectors on the other. The commutator does not differ from the usual type otherwise than in containing more segments and in running at a higher peripheral velocity than is customary elsewhere. The collector is the same as would be used on an alternator. The commutator for a converter must be as large as for a continuous-current generator of the same speed and output. Owing to the absence of armature reaction under favorable conditions of working, and to the higher frequency at which the converter operates, the magnetic circuit of a converter should, if the machine be consistently designed, be small in comparison with that of a similar continuous-current machine. A machine designed for a continuous-current generator would probably make a good converter, but the reverse is not necessarily the case.

There is probably no machine extant today which is not the outgrowth of a considerable period of evolutionary action and the last of a variety of types. This is true of the converter. For more than half-a-century there have been machines which converted alternating into continuous currents. Today there are many very interesting devices for this object, some of which may be developed into commercial form but at present are of interest only to those making a special study of the subject. The converter as above described is the only one at present in use on a large scale in the United States, and will be the only type here considered. In France, a type of revolving commutator having special transformers and a large number of collector rings has been developed. The high frequencies in use abroad have not been favorable to the development of converters.

If the commutator be removed and in its place another set of collector rings be substituted, the machine may be used as a phase converter. With further modifications it may be used to transform from one frequency to another.

Neutralization of Armature Currents and Heating. The individual peculiarity of the converter, which differentiates it from all other electrical apparatus, is the neutralization of currents in the armature conductors. The maximum potential of any alternating-current lead is reached when the commutator bar to which it is connected is passing under a brush. Its potential is zero when midway between the brushes, at unity power factor. Thus in the coils of a set the alternating and continuous current will part of the time be flowing in the same direction and part of the time in opposite directions. In the figures on the next page are shown diagramatically the connections commonly used for converters. The diagram represents a commutator between two field poles. To the proper points on the commutator are connected the alternating-current leads which run to their respective collector rings. The figures show two-pole machines, but these are simply the units of which machines of any size are constructed. In a four-pole converter everything except the collector rings would be duplicated, etc.

The names were given to the different systems before their relations were thoroughly understood. Thus the two-phase (so called) really comes between the three-phase and the six-phase. To be scientifically correct, the number of phases by which the machine or system is designated should be the number of alternating-current leads per pair of poles or 360 electrical degrees. We really have no single phase. What we call by that name is a two-phase. Then comes the three-phase, rightly named, after that the four-phase, misnamed two-phase or quarter-phase, and then the six-phase. As will be seen by comparing Figures 2 and 4, the six-phase consists of two interspersed three-phase systems and is taken from three transformers.

By an examination of Figure 1, we may obtain an idea of what occurs in the armature of a converter. The continuous-current brushes are designated as B_1 and B_2. Suppose the armature to be revolving anti-clockwise. At the position shown the alternating-current leads are midway between the brushes and the alternating electromotive force is zero. Also in this position the alternating current, supposing it to be in phase, is just reversing. As the lead 2 approaches brush B_1, the alternating electromotive force rises until when the alternating-current leads are directly under the brushes the maximum alternating-current voltage is equal to the continuous current voltage and in no case can it be higher. This is assuming that the machine is converting from continuous to alternating currents, which allows the explanation to be followed more easily. When the alternating-current leads are directly under the brushes the alternating current is a maximum, is equal to the continuous current in value, and flows directly through from commutator to collector without passing through the armature winding. Beyond this point the alternating current begins to decrease until when lead 2 occupies the position of lead 1 it again reaches zero.

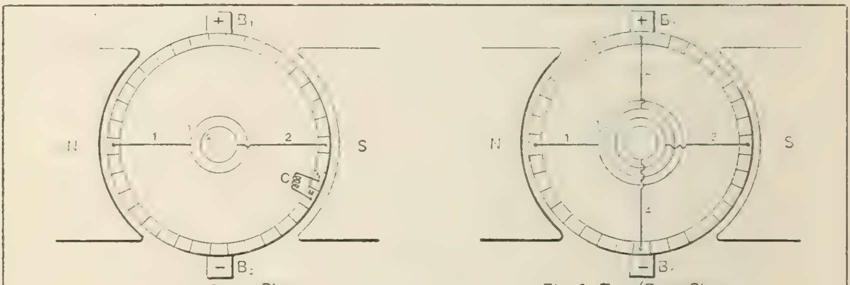


Fig. 1 Single Phase Fig. 3 Two (Four) Phase

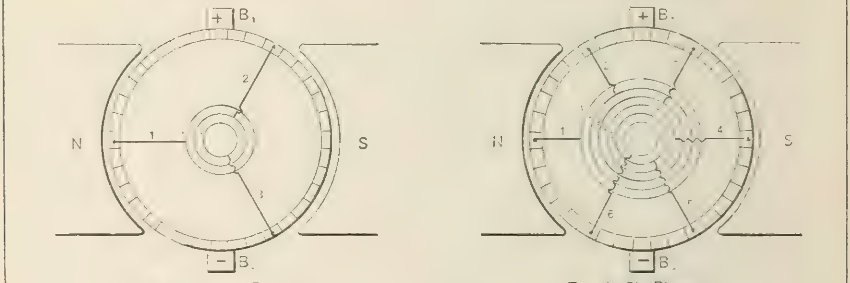


Fig. 2 Three Phase Fig. 4 Six Phase

FIGURES 1 TO 4. CONNECTIONS USED FOR CONVERTERS.

To investigate what happens in the armature winding, let us take any coil as C. While the coil C is passing from B_2 to B_1, the continuous current in the coil remains constant in value and in direction. When lead 2 is directly under brush B_2, before it has come to its present position, the continuous current, entering the armature at brush B_1 and flowing out at brush B_2, will flow through the coil C in the direction M to N. As lead 2 passes under brush B_2 the current flows directly through from commutator to collector, and as the current is flowing out at brush B_2 it must at that instant be flowing in through collector ring 2 and lead 2. As the alternating current is zero only at the position shown by the leads, either as numbered or reversed, the alternating current does not change in direction although it does in value between these two positions. So that just before lead 2 reached brush B_2 the alternating current was passing into the armature by lead 2 and out by lead 1. Thus alternating current flows into the armature by lead 2 during the time occupied in passing from the position of lead 1 to lead 2. The continuous current in a coil is constant in value and is reversed in direction when passing under the brushes. Thus while lead 2 is passing from position 1 to position 2, the alternating current flows through coil C in the direction N to M—that is, opposite to the continuous current—until coil C passes under brush B_2—and then in the same direction until position 2 is reached. Here the alternating current reverses, and the currents again flow in the same directions until coil C again passes under brush B_1. Hence it is seen that the instantaneous current in the armature conductors is sometimes the sum and sometimes the difference of the continuous and alternating currents. Coils occupying different positions with respect to the alternating-current leads, have different resultant currents and for different periods of time. As the heating is proportional to the square of the resultant current, the coils situated near the leads develop much more heat than those lying midway between. In this illustrative case the heat developed in the armature winding is greater than, for the same output, would be the case were the machine acting as a continuous-current generator. As the number of phases is increased the neutralization becomes more complete, until for a six-phase generator the permissible output from the standpoint of heat generated in the armature winding is nearly doubled.

If we consider the output of an armature as a continuous-current generator to be unity, the output for the same heating at unity power factor will be 0.85 as a single-phase converter, 0.97 as a split single-phase, 1.34 as three-phase, 1.64 as two-phase (four-phase), and 1.96 as six-phase.

Frequency. The element of frequency plays an important part in the operation of rotary converters. The early frequencies used in the United States were 133 and 125 cycles per second. As the work done was almost entirely lighting and as the length of lines was not great, these gave satisfactory results. At such high periodicities generators regulate well—that is, give a small drop in pressure under load —transformers are small, and both arc and incandescent lamps work well. Parallel running of alternators, it is true, is not best obtained, but at the period of first introduction of the converter practically none of that was being done. When transmission lines became longer, the fall of pressure, which is greater at high frequencies, became too great and the periodicity of about 60 cycles per second was adopted. This is for many reasons well adapted to the operation of long-distance transmission, and is at present used for those California lines in which power is being transmitted more than 180 miles. The induction motor does not work well at high frequencies, and when the demand came for rotary converters another drop was taken to 25 cycles, which is common practice today for large installations where converters are to be used. For some installations it has been proposed to use from 8 to 12 cycles per second, but this has not been done in the United States. Elsewhere the frequency of 100 was for a long time used, and most of the alternators of European make exhibited at the recent Paris Exposition were built for 50 cycles. In the United States a number of plants have been installed using 40 cycles, and some 30 cycles. Standard American practice may be said to be the use of 60 and 25 cycles.

Converters are not commercially possible at 133 cycles. In cases which are especially favorable, such as water-wheel prime movers and a steady load, when worked in conjunction with storage batteries, they run well at 60 and 66 cycles. Under less favorable circumstances the operation may be satisfactory at these frequencies, but it is more uncertain. At 40 cycles they are to be trusted, and at 25 cycles they are a thoroughly reliable piece of apparatus. Being a commutating machine, it is only when we reach the frequencies of continuous current generators, which range from 8 to 25 cycles, that this function of the converter operates under normal conditions.

In order to illustrate the limitations of a converter, suppose we want to build one for 200 kilowatts, 133 cycles, and 600 volts, continuous current. The limiting conditions are allowable surface velocity and minimum width of commutator bar. A good value for commutator velocity at the periphery is 2,500 feet per minute. If now we sacrifice all we can in this respect and take the upper limit, which is about 5,000 feet per minute, we shall at once see into what trouble we are at once led. We shall not be able to use more than twenty poles, which gives 800 revolutions per minute. This is somewhat immaterial as the width of commutator segment depends but little upon the speed because of the inverse change of the number of poles. With 5,000 feet per minute surface velocity and 800 revolutions per minute, the circumference of the commutator is 75 inches. The maximum difference of potential between bars will be assumed to be 20 volts, although this is too high a value. We need then thirty bars between adjacent brushes, and six hundred bars in the commutator. To get six hundred bars in a commutator 75 inches in circumference is manifestly impossible where the necessary insulation must be at least 1/32 of an inch of mica between bars. This is an exaggeration, but serves to illustrate the difficulty encountered in building converters for high frequencies. There are other features at the same point which do not conduce to satisfactory operation and which cause the machines to spark, hunt, and in general work badly.

Electromotive Forces. There being but one winding on the armature in which flow both the alternating and continuous currents, their electromotive forces stand in a definite ratio to each other. In alternating-current work we use an "effective" value for the electromotive force which is the square root of mean square of the instantaneous values. Then with equal maximum values the effective value depends upon the wave form. By varying the pole arc, the number of alternating-current leads, by changing the air gaps at different parts of the pole arc, and by concentrating or distributing the winding, we are able to vary the form of the generated electromotive force wave. In Figure 5 are shown characteristic wave forms. The second and third are only approximated in practice, while the first is frequently obtained. It is seen how great a variation may in this manner be produced in the effective values which are measured by a voltmeter, with equal maximum values. In single-phase and two-phase converters where the alternating-current leads of a phase are 180° apart the maximum instantaneous value is equal to the continuous electromotive force. Therefore the ratio of conversion depends upon the effective value. As before explained, this value varies with the proportion of various parts of the machine. With the usual form of distributed winding, the air gap is nearly constant over the entire pole arc and the wave form of electromotive force generated by each coil is practically rectangular. Owing to the distribution of the winding these are displaced from each other in regard to time. If we have twenty coils in a set between

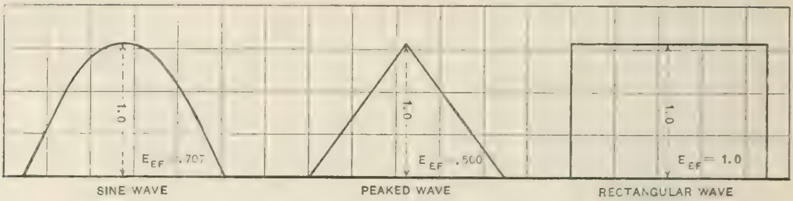


FIGURE 5. WAVE FORMS.

the alternating-current leads, each coil will generate a rectangular wave form, and these twenty similar rectangular forms, when added in series with the time displacement, produce a wave which is practically a sine curve like the first one shown. For most alternating-current working this is the desirable form. When one machine runs from another, which is the case where a converter is run from an alternating-current generator, it is desirable that both generator and converter give wave forms which closely approximate sine curves, and that these be not much distorted under load.

In Figure 1, when the alternating-current leads are directly under the continuous-current brushes the alternating electromotive force is a maximum, and is equal to the continuous-current electromotive force, neglecting a slight armature loss. The effective value of the alternating electromotive force then depends upon the wave form and the ratio of the square root of mean square value to the maximum. With a sine wave which is closely approximated in practice this ratio is $\frac{1}{\sqrt{2}}$ or .707. If we designate by E the continuous-current voltage, that between the collector ring and an assumed neutral will have one-half of this, or $\frac{E}{2\sqrt{2}}$, for an effective value. And to obtain the voltage between any two points on the armature we must combine these electromotive forces exactly as we should mechanical forces, using, however, angles of electrical displacement. In a two-pole machine the actual angle also represents the electrical one, and is therefore of convenience in assisting the understanding. In Figure 1 the alternating-current leads are shown 180 degrees apart. The electromotive force will then be the same in value and direction in these leads at an interval of half-a-cycle. As the two alternations which compose the cycle have equal instantaneous values at the same relative times, but are opposite in direction, the electromotive force between these two leads will be the sum of the individual values and will have an effective mean of .707 times the continuous electromotive force.

EDITORIAL COMMENT

THE place of the great professional society is one which is not always fully appreciated nor understood, and among the ill-informed there sometimes occurs a confusion of ideas which it is not always easy to set right. In the minds of some it is an organisation of which the usefulness is measured by the number of its members or the frequency of its meetings; others look to it as an elementary educational institution, in the sense of the uplifting of the masses, or the provision of opportunities for material advancement, in the personal and limited sense.

It is because of these contracted views that there has arisen a curious opposition in certain quarters to the wise plans of the Council of the American Society of Mechanical Engineers for the broadening of its scope in the true professional sense, as distinguished from the limited usefulness which must accompany the continuance of the present methods of work.

Beyond all question, its true position as a national society belongs upon a far higher plane, and any efforts to oppose the plans of the administration cannot be considered as otherwise than detrimental and unadvised.

Such an organisation as the American Society of Mechanical Engineers cannot stand still; it must progress, and its advance must be upward as well as forward; it must take its place beside the older institutions of Great Britain. Such an advance does not mean an accelerated increase in membership; rather must its growth in that direction be looked upon as necessarily becoming slower and slower, as the eminent engineers of the country are included in its numbers. The real progress must appear in its contributions to knowledge, in the results of its work as evidenced by the fame of its members and the importance and magnitude of their work.

It is evident that such a line of progress means increased expenditure as compared with the slower increase in resources. The cost of the publication of transactions of increasing magnitude and importance, the equipment of research undertakings, the provision for a growing library and cabinets, the demands for more liberal accommodations—all these demand a proportional increase in income and entire freedom from financial restrictions.

When such a most reasonable provision is decided upon by the Council, in due accordance with the rules and long-observed practice of the society, there appears, we regret to see, in some quarters a short-sighted attempt to oppose such far-seeing plans, and to appeal to local and personal elements to hamper and hinder the obvious work which lies before the organisation.

It is greatly to be hoped that such mistaken efforts will not prevail, but that the sounder views of the great majority of the eminent engineers and scientific men who must always form the true strength of such a society will act to maintain the high standing of the organisation, and overrule the attempt to appeal to lower ideas and limited views.

American mechanical engineering today stands in the front rank of the entire world, and the representative organisation of American mechanical engineers cannot afford to be governed by the penny-wise pound-foolish ideas that some would have adopted. Rather let its members rally to the moral and financial support of their Council, and take the stand which is theirs by right, and which can only be taken from them by the mistaken foolishness of a minority of judgment, if not of numbers of their membership.

* * *

THE acumen which leads the shrewd politician to find out which way the procession is headed, and then to get in front of it and cry, "Come on, boys!" seems to be lacking just now in the United States Congress. The "strong and influential men in the Senate and House," according to recent newspaper report, believe that there "ought to be no tariff legislation of any sort at the approaching session of Congress." Meantime the National Association of Manufacturers—once the very priesthood of high protection—is holding its "Reciprocity Convention" in Washington "to discuss the expediency and practicability of the broader application of the principle of commercial reciprocity as a means of expanding foreign markets for American products." And this lead, set by the very element in whose supposed interest the high-tariff religion has always been preached, is followed by boards of trade all over the United States.

But the politicians have not yet waked up. The last thing they heard was "high tariff," and they go on, like Alice's Dormouse, singing in their sleep. "*Twinkle, Twinkle, Twinkle, Twinkle*—" said the Dormouse, "and went on so long that they had to pinch it to make it stop." The "strong and influential men in the Senate and House," if they still dream there should be "no tariff legislation," are very near the point where they will be unpleasantly wakened to activity by their constituents. "'The Dormouse is asleep again,' said the Hatter, and he poured a little hot tea upon its nose."

THE trade in American anthracite for Germany, which Mr. Saward discusses elsewhere in this issue, is taking definite form, recent shipments of 7,000 tons being recorded. The anthracite business is of course a small matter compared with exports of bituminous coal, but even concerning these an unusually able commentator observes that "there is no opposition on the part of interests in Great Britain to the United States supplying Continental markets with coal." One might go further and say it is an enormous and most beneficial relief. The over-pressure upon British mines, while temporarily enabling a few coal owners to make unusual profits, imposes a disastrous burden on industries of vastly larger volume. If the United States can satisfy a portion of this outside demand, the restoration of normal prices and the longer conservation of British fuel supplies will benefit, first, the iron and steel trades; second, the entire volume of manufacturing industries dependent on coal; third, the railways, which would share with the manufactures of the country any advantage of reduced working expenses which might accrue to them by decreased cost of coal.

* * *

A LITTLE knowledge is sometimes a dangerous thing, according to the late Mr. Alexander Pope, and the truth of this observation is again brought home to us when we learn from the report of the American consul at St. Etienne that a new (?) boiler has been designed by M. Serpollet, capable of sustaining a pressure of 80 to 176 pounds per square inch. To this is added the astounding news that locomotives in France carry ordinarily pressures of 35 to 39 pounds! Upon examination we find that the invaluable consul has simply converted kilogrammes to pounds, overlooking the fact that in France pressures are measured upon the square centimetre and not the square inch. His figures are about one-sixth large enough.

REVIEW OF THE BRITISH PRESS

The Gas-Engine Research Report.

The presentation of the second report of the gas-engine research committee of the Institution of Mechanical Engineers is to be welcomed as an important contribution to the literature of a branch of engineering which is of growing importance, and no excuse is needed for discussing it at some length in this place.

The first report, which was presented to the Institution early in 1898, and which was reviewed in these columns in the issue of May of last year, was devoted mainly to a description of the engine and apparatus, with an account of some of the preliminary testing work, and the present report goes very fully into the work which has been accomplished since that time.

The actual testing has been done almost entirely by Professor F. W. Burstall, under the advice and suggestion of the chairman of the committee, Dr. Kennedy, and the methods and execution of the work demand most hearty commendation, especially as regards the valuable and original work in the determination of temperatures.

The engine, which is a small one, especially constructed for the work by Messrs. Fielding & Platt, is of 6 inches bore and 12 inches stroke; and running at 200 revolutions, it generates about 5 horse power indicated. The small size is somewhat against it as an origin of data for theoretical deductions, but the care which has been given to the work upon the trials, renders this objection a minor one.

In the present report some account is given of improvements which have been made in the engine, especially in the electric ignition, which had given some trouble. Experience with high-tension sparking had shown the difficulty of maintaining satisfactory insulation, and a new igniter, using a low potential circuit containing iron, was substituted. By using four storage cells, having a capacity of 50 ampere-hours, a short, thick spark was obtained which has never failed to fire the charge during a constant use of more than two years.

The improved indicator connection is also described, and by the use of an oscillating quadrant, with steel-tape connection, and with steel-wires running to the indicator, all error in the transfer of the piston motion to the indicator cylinder was eliminated.

The system which was followed in making the experiments was to work on four compressions: about 55 lb. per square inch, 71 lb. per square inch, 93 lb. per square inch, and 124 lb. per square inch, the pressures being absolute. The speed was kept the same for the whole of the tests, that is, about 200 revolutions per minute; in all cases the load on the brake was adjusted so as to make the number of explosions missed as small as possible. Experiments on gas engines when a considerable number of explosions are missed give rise to such varying ratios of air to gas as to render them useless from a research point of view; this is due to the fact that when a blank charge of air is drawn in, the residue in the clearance space is more than usually diluted with air, and the indicator diagram following the blank charge is not the same shape as those which follow an explosion. The tests under any of the compressions are given in the order of the ratio of air to gas. The series starts with very nearly the theoretical amount of air which is required to burn the gas, and then the tests are separated by, roughly, changes of 1 per cent. in the carbonic acid as found in the exhaust gases.

All volumes, both air and gas, are reduced to standard conditions, that is, a temperature of 15 deg. Cent. and a pressure of 760 millimetres of mercury; results are given in the metric system, but for the convenience of comparison a few leading figures have been given in the English units also; limits of space prevent the adoption of the dual system throughout.

The ratio of air to gas has generally been found by assuming that at the end of the suction stroke the cylinder is filled with only air and gas; if the temperature of the mixture be assumed, the volume of air can be calculated from the ordinary gaseous laws.

This method is certainly not correct, as there is always in the clearance space a volume of the products of combustion which have been left over from the previous explosion stroke; the temperature of the mixed air and gas has been generally taken as not differing greatly from the jacket temperature, an assumption which is not in general borne out by the present experiments. If an accurate analysis of the exhaust gases can be made, it is possible to find the ratio of air to gas in a somewhat similar manner as in boiler tests, where the weight of air per pound of coal is found from the analyses of the flue gases and coal.

For any given mixture of air and gas it is possible to compute the temperature, this computation involving the measurement of the air drawn in during the suction stroke, and the composition and volume of the air and burnt products filling the clearance space after the exhaust valve has closed and a new stroke is about to commence. The method of these computations is given in detail in the paper, and the results are plotted in a curve for comparison with the experimental determinations.

In collecting the data for the preparation of a heat balance, Professor Burstall has taken into account the variable specific heat, and gives the formulas for its computation. If constant specific heat be adopted it will be found that during expension there is an apparent gain of heat instead of a loss to the walls, but if the hypothesis of a variable specific heat be adopted there is in almost all cases heat lost to the walls. By drawing adiabatic curves upon the diagrams, and comparing the temperatures and pressures, Professor Burstall shows that the experiments prove that the expansion curve should be nearly an adiabatic if maximum economy is to be attained, and that all the heat should be added at maximum temperature, and that any after burning is detrimental. Thus these tests fully support the theory of Diesel on both of these important points.

Reference has been made to the temperature tests, which are of the utmost importance and value. For this purpose the electrical-resistance pyrometer of Professor Callendar was used, and a very detailed account of the manner in which the pyrometer was applied is given in the original paper. Great care was taken to insure that the wire actually followed the temperatures to be measured, the temperatures being taken in the central clearance space, which would naturally be the hottest part. The results are tabulated in their proper place in connection with the other data and results, but it may be interesting to note that the maximum was very nearly 2,000° C.

The heat balances of the various trials are worked out very fully, and the manner in which the entire research has been recorded will enable the data to be used as most valuable additions to the practical study of the thermodynamics of internal combustion motors.

The thermal efficiency of the engine, using illuminating gas with a calorific value of about 5 calories per litre, varied from 17 per cent. at the lower compression, to 23 per cent. for the higher compression, the efficiency being based on indicated horse power; the mechanical efficiency of the engine being about 75 per cent.

The computations and results of the tests are given in the metric system throughout, with the conversion of a few of the more important quantities into English units. This may offer some inconvenience to readers, but enables the results to be readily compared with similar researches made in France and Germany.

Feed-Water Purification.

The information prepared for the use of the Manchester Steam Users' Association often contains much that is valuable to the engineering profession at large, and the data issued by the chief engineer of the association, Mr. C. E. Stromeyer, concerning the purification of feed water and published in *Engineering* demand attention.

It is now very generally understood

that it is much more desirable to remove impurities from feed water before it enters the boiler than afterwards, especially if it is at all liable to form hard scale. There is but one way to prevent the formation of scale, and that is to be treating the water before it is fed into the boiler, so that apart from questions of safety, the matter is resolved into a comparison of the cost of purifying the water as compared with that of cleaning the boiler.

Assuming the cost of scaling and cleaning at 30 shillings per boiler, Mr. Stromeyer tabulates the annual cost of maintaining a boiler under various conditions of foulness, including an estimate of the probable lifetime of a boiler under the various conditions. The probable ages of boilers are based on the assumption that the gradual accumulation of scale during the time that each boiler is allowed to run will increase the wear and tear, and also on the boilers get little rest they will not be so well scaled as in others.

The annual cost, chiefly interest for a boiler using pure water with only such chemicals as are necessary to prevent corrosion, is about £35, while boilers using fact that in those installations where the sedimentary waters would cost from £37 to £75. If, then it can be shown that the interest, depreciation, and working expenses of a water-softening apparatus per boiler amounts to less than these extra expenses, the advantage in connection with very sedimentary waters is demonstrated.

Mr. Stromeyer gives a summary concerning fifteen water softeners which need not here be discussed in detail, but some of the more conspicuous features may be mentioned.

The principle of water-softening is very simple. The temporary hardness, caused by dissolved carbonate of lime and magnesia, is removed by the addition of a certain quantity of burnt lime, this causing precipitation to occur. The permanent hardness is removed by the addition of carbonate of soda, this causing further precipitation. The practical difficulties are found in the separation of the precipitates. The precipitate caused by the carbonate of lime especially, is very slow in forming, so that it is necessary either to use very large settling tanks, or else to devise some method of filtering, and it is in the perfection of details for this portion of the separation that the various differences in the devices on the market are found.

One of the practical difficulties which has been met in the use of purification devices has been the failure of the user to adhere to the instructions of manufacturers. In one case cited, it was found that double the proper quantity of lime was being added, thus rendering the water harder than before it was treated. In another instance the settling tanks had never been emptied, but had become filled with sediment, which had grown as hard as rock. When it is understood that water softening devices are intended to be intrusted to the tender cares of firemen, it will be seen that the utmost simplicity should be secured both in construction and in handling.

The various improvements in the process are divided into several classes. The treated water may be mixed with old sediment, as it is found that this, in again settling, carries down much of the new precipitate with it. Mechanical devices for stirring, or the use of air jets, may be resorted to to accelerate the precipitation or the water may be heated. These methods all have their advantages and disadvantages, but Mr. Stromeyer describes each in detail and leaves the user to decide which is best adapted for his service.

Some water-softeners work continuously; others are so arranged that a tankful is prepared at a time. When the latter method is adopted there is no difficulty in adding the proper quantity of chemicals, but with the continuous devices some special method must be employed, and many ingenious methods have been suggested. In some softeners the flow depends on the size of nozzles, in others on the difference of density, and in others, again, small measured quantities are tipped into the feed by mechanical means. Probably the old arrangement of using adjustable pumps is the cheapest and most reliable.

If the proper attention is given to cleaning there is no method which is so effective in purifying feed water as the use of heat, and much of the scale can be prevented simply by using the heat of exhaust steam to raise the temperature of the feed water to about 210° F., and providing space and time for the precipitated carbonates to settle. If sulphates are present the addition of a small quantity of live steam is necessary, to raise the temperature above the boiling point, but the heat taken from the boiler in this way is nearly all returned to it with the feed water and but little loss follows.

The main thing to be emphasised is the importance of doing whatever needs to be done to the water before it enters the boiler, instead of putting any chemical into the boiler itself. If Mr. Stromeyer's recommendations do nothing more than make this point understood and practiced by steam users, his paper will prove a most valuable addition to the literature of steam engineering.

Superheated Steam.

AMONG the interesting papers presented at the mechanical engineering section of the Glasgow Congress may be noted that of Mr. R. Lenke, upon the use of highly superheated steam in engines, and some extracts are here given as worthy of practical attention and thought.

Saturated steam, or steam which has exactly the temperature due to its pressure, has aptly been described as steam saturated with heat, and the chief peculiarity which it possesses is that the slightest abstraction of heat is followed by a corresponding condensation.

"Superheated steam is generated by the addition of heat to saturated steam. The behavior of superheated steam is similar to that of gases; it is a very bad conductor of heat, and has the special peculiarity of being able to lose a certain amount of heat without becoming saturated or wet steam. The thermal capacity of steam is only 0.48, therefore very little heat is required to superheat steam; but as the steam loses the heat as quickly as it acquires it, every passage conveying superheated steam must be well covered with nonconducting material. Although there are some losses when using superheated steam on account of the heat radiation, they are very much smaller, because the loss of heat from superheated steam has lower calorific value than the latent heat of saturated steam."

The question of the cost of the additional heat is sometimes raised, but it can be shown that less heat is required to produce a cubic foot of superheated steam than to generate a cubic foot of saturated steam of the same pressure.

"The economy effected by using superheated steam in engines is very remarkable, and, acknowledging this fact, a great number of steam users all over the world superheat the steam, although in many cases only a few degrees, yet a considerable saving in steam and coal is always the result. To obtain the full benefit the required temperature of steam is 660 to 700 degrees F., and to stand this temperature the engines must be specially designed. It is not sufficient to use mineral oil with a very high flash point, and any one who tries to supply an existing engine of any kind with steam at that temperature will have a very unpleasant experience, even when using the above mentioned oil.

"The introduction of superheated steam into engines largely influences the expansion of the heated parts. Engines always gave great trouble when the distribution of metal in the cylinders was not uniform, as parts with more metal expanded most and forced the cylinder walls toward the inside and made the cylinder out of shape. When using liners in the cylinders they were squeezed in at the ends, decreasing the diameter and jamming the piston body if sufficient clearance was not provided. With steam jackets heated with steam of 500 degrees F. the lubrication ceased as the cylinder walls became too much heated, consequently it was found necessary to do away with jackets, or if jackets were already provided, not to pass steam through them. Pistons constructed on the Ramsbottom type always work satisfactorily, except in the case of pistons fitted with steel springs, when they are in contact with highly superheated steam. Any kind of gun metal gets brittle after a very short time, therefore valves, seats and all parts in direct contact with superheated steam must be made of cast iron or other suitable mixture. Copper also loses about 40 per cent. of its strength at that temperature, consequently copper bends in pipes are not practicable. The best material for piping has proved to be wrought iron and steel, each pipe being as long as possible, to have the least number of flanges. For long straight pipe connections provision must be made to meet the expansion, which is, at 700 degrees F., 0.037 of the length, so that, for example, 100 feet of pipe extends 0.37 foot, or nearly 4½ inches."

One of the most troublesome effects of expansion is found in the action of the steam valves. Slide valves and Corliss valves are naturally affected by the high temperatures, 480 to 500 degrees being the upper limit for the latter. Piston valves, when carefully constructed and proportioned, answer well, but they must be made especially for the service, or they will not answer. The longitudinal expansion of the cylinder tends to deform the steam chest and valve-seat, and provision must be made for such effects. Rings and springs in valves are objectionable, as it is difficult to keep the steam from getting between the rings and creating increased pressure and friction. Poppet valves have been used with much success, notably in the Schmidt engine, but care must be taken that the spindles do not stick.

"Besides the economy the use of highly superheated steam has some other advantages which are also important. It makes the steam consumption nearly independent of the size of engine, as a small engine has about the same steam consumption as a large one, as for example: An 80 horse-power compound condensing engine uses 10.45 pounds of steam at 160 pounds pressure and a 1000 horse-power engine uses 9 pounds of steam per indicated horse-power per hour. The use of highly superheated steam does not require high boiler pressures; 160 pounds is the highest to be recommended, as no advantage can be derived by exceeding this. As the amount of heat transmitted from the steam to cylinder walls, and *vice versa,* is much lower with superheated steam than with saturated steam, the whole range of temperature from boiler pressure to vacuum can take place in one or two cylinders, so that the use of a triple expansion engine does not make the slightest improvement in economy. It is not intended to be understood that the author proposes to do away with all triple expansion engines; for very large plants their use will be necessary for constructive reasons.

"Superheated steam engines use on an average 30 to 40 per cent. less steam than saturated steam engines of the same type. Consequently boilers can be made 30 per cent. smaller, and the difference in price will nearly cover the cost of the superheater. For the same steam consumption the superheated steam engine is cheaper, as it may be worked with a lower boiler pressure, and it is simpler—*i. e.,* instead of a compound engine with saturated steam, a single cylinder engine with superheated steam may be used, giving the same or better results than the former.

"In view of the great advantages of steam superheating, and the great number of engines running at present satisfactorily, it is astonishing that a few failures have caused prejudices among some engineers, who make the general introduction of the use of superheated steam very difficult. It will be worth mentioning that the results of a great number of trials have always proved a great saving in steam and coal, and even with small plants and simple piston valve engines almost the same good economy is obtainable as with large engines with most exact valve gears. It is therefore recommended that superheated steam should be used in connection with all engines; the only question to be settled is the degree of superheat, which largely depends on local circumstances and the construction of the engine, and this matter should be left to the judgment of an experienced engineer."

Variations in Electrical Conductivity.

It is generally understood that the fundamental principle employed in space telegraphy is the manner in which small metallic particles have their electrical conductivity increased under the influence of magnetic waves. The coherer, which in its present form is generally admitted to be due to Branly, consists of a small glass tube containing such metallic particles, and when this tube, forming a part of an electric telegraphic circuit, is exposed to the action of a magnetic wave, the particles cohere and the current is permitted to flow.

The very thorough study which has been given to this curious action by Professor Jagadis Chunder Bose, renders his paper before the British Association a very important contribution to this branch of electro-physics, and a brief abstract is of interest.

The behaviour of the particles in a coherer is generally assumed to be that which is indicated by its name, i. e., that the particles necessarily unite and have their conductivity somehow increased by their sticking together, this idea being further conveyed by the knowledge that in practical systems of space telegraphy the coherer must be tapped to effect decoherence after it has been acted upon by a magnetic wave.

As a matter of observation, however, various effects may be produced by magnetic waves, and there really appears to be some sort of a molecular change produced, the nature of which is by no means clear.

We know that the physical properties of a given substance depend on its molecular condition, and it is but reasonable to expect that any molecular change should be accompanied by physical changes, among which conductivity is included. The wide difference in electric conductivity of the same substance under different molecular conditions is seen in the case of carbon, in its two allotropic forms of graphite and diamond. That radiation is effective in producing allotropic changes is seen in the conversion of the yellow into the red variety of phosphorous under the action of light.

Instead of the mere production of conductivity, it is found that this is but one effect which may be produced by magnetic waves. As pointed out in a previous paper by Professor Chunder Bose, substances may be classified with regard to their sensitiveness to electric radiation into three types, positive, negative, and neutral, differentiated by the characteristic curves of variation of current with electromotive force.

In order to study the whole subject from this broad standpoint the author made a number of experiments with a most interesting apparatus which he terms a curvograph. Previous experiments had been made by subjecting particles in a tube to variations of electromotive force by the use of a potentiometer arranged with a sliding contact; the position of the slider and the deflection of the galvanometer giving points in a curve. The practical difficulties which were encountered with this apparatus led to the construction of an automatic recording device, based upon the same principle. The galvanometer was replaced by a reflecting mirror instrument, and the spot of light was reflected downward by a fixed mirror, so that it was thrown upon the surface of a horizontal platform. This platform was connected with the sliding portion of the potentiometer, and bore upon its upper surface a sheet of sensitive photographic paper. The compound motion of the sliding platform and the galvanometer mirror caused a curve to be traced upon the paper, such a curve being characteristic of the materials under examination. It is impracticable to go into the discussion of the results of the experiments in this place, but in the paper of Professor Chunder Bose, which is reprinted in full in *The Electrician,* copies of numerous curves are given and their exhibition of the behaviour of the substances examined is discussed. Briefly the conclusions are that the changes in conductivity which appear are not chemical, but appear to be molecular. The conduction does not obey Ohm's law, but varies with the electromotive force, instead of being independent of it. Certain substances have their conductivity changed under the stress of electric radiation, but recover as soon as the stress is removed, thus exhibiting a close analogy to a mechanical stress within the elastic limit.

These and a number of other properties are revealed by the curves drawn by this ingenious apparatus, and since we are promised further accounts of later experiments, we cannot but anticipate revelations which may materially change accepted notions concerning electric radiations in general, as well as the manner of their action in space telegraphy in particular.

Railway Goods Traffic.

MUCH has been said about the greater economies which are effected in the hauling of merchandise by American railways as compared with those of Great Britain, but so much unintelligent matter has been printed about it that it is refreshing to see the subject so well discussed as in a recent article in the *Engineer.*

Trains of 2,000 tons, and hauls of 1,500 miles may be economical in the United States, but there is hardly a place for them in Great Britain, while as to 50-ton cars, their use is hardly practicable without an entire reconstruction of all the handling machinery at the docks and elsewhere.

Improvements are undoubtedly possible in British methods, but they must be based upon British conditions, and not upon conditions which exist elsewhere and are physically impossible in England. The greatest opportunity for improvement lies in the reduction of idle wagons, and the maintenance of a higher degree of efficiency with the present equipment.

The great difficulty the railway companies have to contend with in dealing with mineral traffic arises from the merchants, iron masters, and colliery owners keeping the railway wagons loaded both in iron ore and coal districts until it suits their convenience to unload. A very large proportion of the coal moved is for small consumers of, say, one ton, and no provision is made for proper unloading and storage at the mineral depots. The railway companies and traders stand very much in their own light in this respect, when, in distances of only twenty miles they consider themselves well off when they get one to two runs a week out of their wagons.

It is unnecessary to multiply examples to show that the first place to effect economy lies not in increased sizes of wagons and trains, but in a more expeditious handling of existing facilities. This can be done entirely by better terminal and station management, together with the intelligent cooperation of customers and shippers, who should be aroused by the offer of lower charges to provide increased facilities of their own. Traders must be made to see that it is their interest to provide proper means for disposing of their goods or minerals rapidly and cheaply when they reach their destination if any improvement in the reduction of transport is to be effected.

In other words, more economical railway goods traffic is to be secured in Great Britain by British methods, adapted to British conditions, and not by the importing of methods from some other part of the world, and especially from a country where conditions are essentially different.

Factors of Safety.

It seems almost like heresy to attack the hoary institution of the factor of safety, but that is what Mr. Robert Henry Smith has done in his presidential address before the Civil and Mechanical Engineers' Society, and we must be thankful to him for it. He does not deliberately demand that the factor of safety be abandoned or that it be replaced by some other method of providing for the unknown elements in a computation, but he does demand that it be understood and applied intelligently.

"Factors of safety are ratios in which pieces are made stronger than is required by calculation, according to the theory of strength employed, in order to allow for various kinds of uncertainty as to the exact value of the data, and to allow also for corrosion and abrasion. Sometimes uncertainty arises from doubt as to the legitimacy and theoretic accuracy of the formula or mode of calculation employed. This element of uncertainty would not exist if the method of calculation agreed closely with a theory of whose completeness and accuracy we were quite sure. Many formulas are employed, however, in which niceties and difficulties of theory are confessedly, and indeed, very often deliberately, left out of consideration. Very often the calculation is made on the assumption of uniform distribution of stress over the section, when it is well known that the stress varies largely from side to side of the section. In sections through joints of all kinds in machinery such large deviation from uniformity exists—sometimes the maximum stress is three times the average. The theoretic estimates that have actually been made of this deviation are doubtful in respect of accuracy, and, in any case are very seldom made use of, or even known by the practical designer. In many sets of circumstances such as these, and occurring most largely in connection with machinery, a very considerable part of the "factor of safety" found to be necessary is evidently attributable to the wrongness of the theory, which is the base of the formula. In many cases the theory or formula is known to be wrong, or, at least, incomplete; but it is not known in what degree its results differ from the true results. In other cases the incorrectness of the formula is not suspected by the man who uses it. Whether or not this be so evidently depends upon the amount of scientific and practical education that the user has received in the colleges and in works. Here it might be well to note that none of us have as yet received so complete an education that we can always feel quite reasonably secure against an error of judgment as to the absolute reliability of any particular theory. But the important point to notice is that in cases in which it is desirable to adopt a formula as the standard for the practice of a profession, that formula must of necessity base itself upon the knowledge possessed by the average member of the profession. Thus there will be inevitably applicable to such a formula a factor of safety which includes compensation for the average ignorance of the profession. This average ignorance may be so different in Germany, France, England, and America, that different formulas rule the practice of these different countries, and correspondingly different factors of safety may be quite proper in these different parts of the world. But there are numberless details of design not settled by any series of rules which it is incumbent to impose upon a whole profession or trade. Then comes in the greater or less accurate theoretical knowledge of the individual designer. If one man designs merely in proportion to the average stress, he must use a larger factor of safety than is properly used by a man who can, and takes the trouble to search out the variation of stress across the section and makes allowance for it in his theoretic calculation.

"Thus, probably, a part of the whole factor used is due to the doubtfulness or ascertained defectiveness of the theory embodied in the calculation, and the ratio representing compensation for this must vary very largely with a number of conditions which are external to the physical nature of the problem itself."

Shipping Subsidies.

Among the papers presented before the British Association, we may note one read before the Economic section by Dr. B. W. Ginsburg, dealing with the question of shipping subsidies, and while the general trend of the paper was somewhat beyond the scope of the work of the engineer it contained some very suggestive features.

Referring to the question of commercial cruisers, receiving subsidies as such, it appears that England possesses two ships of 22 knots' speed, the Campania and Lucania, and three of 20 knot, the Teutonic, Majestic, and Oceanic; while in Germany's list the five fastest ships range between 23½ and 21 knots. France has four 22-knot ships on her list and building, Russia has six 20-knot ships, the United States, two 21 and two 20-knot vessels.

Discussing the policy of building very fast liners, it appears that the Deutschland is about 15 per cent. larger than the Ivernia, but cost about 50 per cent. more. The German ship has a crew of 553 persons; the Cunarder has but 257. The indicated horse power of the Deutschland is given as 35,000; that of the Ivernia is 10,500. The Ivernia carries a huge cargo, as well as a fair number of passengers, and has been running steadily ever since she came out, while the Deutschland did not run between November and April.

A detailed discussion of the subsidies given by various countries to mail carriers and to mercantile cruisers forms a large part of Dr. Ginsburg's paper. In conclusion he says that at present Germany is England's most successful rival.

The encouragement she gives to ships is devised wisely, but on a liberal basis. Her development during the last ten years is most remarkable, but it should not be forgotten that her percentages of increase are calculated on a figure originally small. When it is seen how her two great lines have come triumphant out of serious difficulties, it would seem to be suggested that amalgamation in shipping might strengthen British hands. State aid in England cannot be expected for any industry; the genius of the people is against it. Without attempting to teach their business to shipping men it must be remembered that sometimes new adventures have to be carried on at a temporary loss, and it sometimes pays to give facilities which the actual trade does not warrant. It would almost seem that in certain branches of the shipping trade, at least, there has been no private company which saw its way to risking the initial loss to open up a new line, and so the State-aided foreigners has crept in. In other branches it is possible too much reliance had been placed in an old name and existing connections, whilst no attempt has been made to meet threatened opposition. It is certain that in any naval war England would severely feel the want of vessels like the Kaiser Wilhelm II. and the Deutschland.

REVIEW OF THE CONTINENTAL PRESS

The Drop-Testing of Metals.

For a long time it has been a matter of much importance to ascertain within reasonable limits the strength of metals used in construction, especially of iron and steel, and during the past few years great advances have been made in methods of testing and recording results. A recent paper in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale,* by M. Ch. Frémont, treats broadly of the study of the strength of materials, and especially of the usefulness of the drop test, and contains much matter of interest and importance.

As long ago as 1734 Swedenborg, in his *Traité du Fer,* states that it was the practice of Swedish and English iron merchants to test the quality of iron bars by noting their behaviour under blows, while Grignon, in 1775, states that the quality of a bar of iron could be determined by nicking it and then breaking it at the nick, and examining the nature of the fracture.

Although the drop test has been practiced for nearly two hundred years, the tension test is fully as old, having been used by Muschenbroek in 1722, his example being followed by such famous men as Perronet, Gauthey, Rondelet, Navier, etc., and as this form of test is able to provide a numerical statement of the resistance of a specimen upon which a factor of safety can be based, it has come into general use. Until recently the drop test has been looked upon merely as an auxiliary to the tension test, but it has of late been developed to especial advantage since the general use of steel has made some method of determining brittleness essential.

For a long time, however, it has been realised that a metal which might give an excellent result under the tension test, might also be readily fractured by a blow or shock, especially if any crack or surface defect had formed. A test piece which gave a high tension test, with ample elongation, often showed a sudden fracture when struck a sharp blow, after a slight nick had been made in the surface, which would have been fatal in a completed structure.

These facts evidently furnish an explanation of disasters otherwise mysterious, such as boiler explosions, the breakage of rails, axles, tires, etc., when previous tests of the materials under elongation had been altogether satisfactory.

Naturally the use of the drop test is suggested as a method of determining the resistance of a metal under such conditions, but the drop test possesses certain disadvantages. In the first place it is usually a qualitative, but not a quantitative test, and therefore comparisons between various tests have not been practicable. Also it has been recognised that unless the same conditions obtained in all tests no definite record could be made of value for future reference. M. Frémont shows also that the results are very different if a test bar is broken by a number of moderate blows applied consecutively, or by a single heavy blow. It is to remove these indefinite characteristics from the drop test that M. Frémont has devoted his efforts.

The first condition imposed by him is that a drop test should be made by a single blow producing rupture of the test piece. This condition demands that in every case the blow should be heavy enough and made with sufficient velocity to insure rupture. The earlier method was to prepare a number of similar test pieces from the same metal, and subject these to a series of drops of gradually increasing height, with but one drop to each piece, until one piece is broken. M. Frémont, however, has greatly simplified this method, besides adding to its accuracy, by devising a system for measuring the residual living force in the ram after the drop has ruptured the test piece; the difference then giving the resistance of the material. For the details of the device the reader must be referred to the original paper, but it may be briefly described as consisting of a sub-stage to the anvil, supported by springs, and receiving the blow only after the rupture of the test piece. The test piece is nicked, and the ram carries a projection which strikes in the nick, thus effecting the rupture, after which the residual energy of the ram is received by the springs and recorded automatically. This recording apparatus is calibrated by drop trials made without any test piece in the machine, so that the computed results are verified experimentally, and may be determined in terms of height of drop.

The use of the apparatus is very simple, since the height to which the ram is lifted is controlled automatically, and all the attendant has to do is to place the previously prepared test piece on the anvil and wind the ram up until it drops. The weight of ram remains constant at 10 kilogrammes, and the height is uniformly four metres, so that it is only necessary to examine the recording apparatus to determine the residual energy to be subtracted, in order to determine the resistance of the specimen.

M. Frémont has decided, after numerous experiments, to use a standard test piece of rather small dimensions, being 10 millimetres wide, 8 millimetres thick, and 30 millimetres long. These dimensions permit specimens to be readily cut from boiler plates, plates for shipbuilding, and similar work, as well as of heavier parts, and experiments upon more than 10,000 specimens have convinced him that reliable results may be obtained from such pieces.

In order to make sure that the test gives the brittleness of the piece a nick is cut across the top of the test piece, this being made with a saw 1 millimetre thick. Tests have shown that the actual depth of the nick, within certain limits, is without appreciable effect upon the result, the figures being practically the same for depths of 1 and 2 millimetres.

Results of a number of tests are given in the paper, together with much interesting information showing the unreliability of tension tests alone for the determination of the suitability of a material for any service in which it may be subjected to shock.

The enormous importance of the subject is so apparent that we feel sure that such tests will soon be required in specifications for materials of construction in addition to the usual tests for tensile strength.

High-Speed Steam Locomotives.

As a result of the attempts to design an electric motor car which shall be capable of operation at a speed of 200 kilometres per hour, or about 125 miles, there has arisen a discussion as to the practicability of accomplishing such a velocity with steam locomotives. While such a result evidently depends as much upon the road-bed as upon the motive power, yet assuming like conditions as to permanent way for both electric and steam locomotives, it is altogether possible that the steam engine may equal the electric motor, even though the latter possesses the great advantage of freedom from reciprocating parts.

In a recent issue of *Glaser's Annalen,* Herr Rolf Sanzin discusses the essentials of a steam locomotive to make a speed of 200 kilometres, and some of his points are of general interest, apart from the question of the desirability of realizing such speeds.

As he rightly says, the most important detail of such a high-speed engine is the boiler, The greater the heating surface and grate, the greater the capacity for power and generation. At the same time it is important that the weight be kept within reasonable limits, and hence the efficiency of a boiler for such a service is to a great extent measured by the ratio of its power capacity to its weight. This point holds good for the rest of the locomotive as well, for although the machine must necessarily be a heavy one, it is essential that every pound shall represent useful operative machinery.

These conditions at once indicate the use of high steam pressures, superheating, multiple expansion, and all methods of increasing power without involving a proportional increase in weight.

Herr Sanzin gives details of the general proportions of such a steam locomotive as appears to meet the requirements of high speed, taking an engine of 60 tons weight for the locomotive and 40 tons for the tender, with motive power of 1,500 h. p. He is inclined to favour the forward bogie truck, and if it can be arranged to avoid taking too much weight from the driving wheels, he considers that a six-wheel truck might be advisable. For the drivers the arrangement of the well-known "Atlantic" type of American locomotive appears good, since this permits the use of a wide deep fire box without interfering with the employment of driving wheels of large diameter. With this design it appears practicable to build an engine of 2,000 h. p. at a total weight of about 110 tons weight, allowing 35 tons for the tender, and the use of track tanks for replenishing the water supply.

There is no doubt that a large part of the problem of exceedingly high speeds depends upon the condition of the roadbed. Already steam locomotives are making runs at 140 to 150 kilometres per hour, and 180 kilometres has been attained for a brief spurt upon existing roads, so that it appears as if the 200 kilometres speed should be attainable without any material revolution in locomotive design.

The Berlin-Zossen line, upon which the experimental runs of the electric cars are being made, has been constructed especially for such speeds, and all the conditions of alignment, smoothness and stability have been considered and met. If such conditions are taken into account for steam railways, conditions which mean much straightening of curves, and removal of grades, the performances of existing locomotives would doubtless be improved, so far as speed is concerned.

In view of all this discussion about high speeds, it is pertinent to inquire into the existence of other conditions which might more readily be corrected, and which affect the real speed of transport to a large degree.

The real speed of transport is measured by the time which is required to deliver the passenger from his starting point to his destination, and the running speed of the train upon the road is but a single element in that undertaking. In very many instances the passenger is required to be at the railway station long before the actual starting time of the train, in order to avoid crowds, secure places, attend to luggage and do a number of things which must be done, but which are not now charged to the speed of the transport. Upon his arrival at the terminus he usually is deposited upon a platform many hundred yards from any local conveyance, amid crowds which interfere with his progress, and subjected to many delays.

As a result the actual time of his departure and arrival between his individual starting and stopping places may be divided into two portions, one made up of time consumed in getting from his own starting point to his seat in the train plus the time required after leaving it before reaching his destination, the other portion consisting of the actual time of the train upon the road. For journeys of moderate length, the former portion often equals, and even exceeds the latter.

It is altogether possible that many of these delays, incident to railway transport, and not included in railway running time, might be very materially reduced, at much less cost than would be involved in saving an equivalent amount of time upon the road. Greater facilities for ticket taking and luggage handling, would permit the passenger to defer his arrival at the station until a few minutes before the departure of the train, and yet be assured of immediate and competent attention, as well as certainty of a comfortable place in the train. Upon the arrival the use of traveling platforms would facilitate the clearing of trains and the delivery of passengers to the local cabs and tramways; luggage of all kinds being rapidly and carefully sent to the ultimate destinations. All these features would cost money, but much less money than the boring of tunnels to straighten curves, or the digging of cuttings to remove grades. The principal difficulty in saving time by such methods lies in the inertia of officials, and the unwillingness to change methods which appears to be inseparably connected with all great corporations which approach the governmental in their desire to have things remain as they are.

Engineering Laboratories.

It was not so very long ago that the general meaning conveyed by the word laboratory was exclusively that of a chemical laboratory, the idea of a department of scientific reasearch not having been sufficiently extended to other branches of work to permit the extension of the word to its full etymological meaning. At the present time we have physical laboratories, physiological laboratories, and finally mechanical laboratories, and the latter have become among the most important adjuncts of technical and scientific education.

In a recent issue of the *Zeitschrift des*

Vereines deutscher Ingenieure is given an account of one of the most recent and complete of these engineering laboratories, that of the Technical High School at Stuttgart, the description being prepared by Professor Bach, himself being known as one of the ablest technical instructors and original investigators in Germany. The present laboratory has grown up under his own supervision since his entrance upon the duties of professor in 1878, there being at that time nothing whatever in the shape of a department of practical experiment and research in existence at Stuttgart.

The general idea of the laboratory, as laid out by Professor Bach, was to permit original research upon two lines of engineering work; one covering investigations upon the strength and other properties of the materials of construction, and the other including researches upon motors of every sort, especially upon steam engines. With the aid of the *Württembergischen Bezirksverein,* the local section of the *Verein deutscher Ingenieure,* a laboratory was started in 1881, especially for the purpose of testing the strength of materials, and this has since developed to such an extent that the new buildings and plant now described, cover both branches very fully.

The location of the laboratory is an excellent one, the proximity to the Neckar canal permitting the use of an abundant supply of water for pumps and condensers, while the neighbourhood of the other buildings of the High School permits the use of the laboratory as a place of combined instruction and research.

The experimental steam engine is a four-cylinder triple-expansion engine, the cylinders being arranged horizontally in pairs, tandem, the cylinders being 250 millimetres in diameter for the high-pressure, and 400 millimetres for the intermediate and low-pressure cylinders, with a common stroke of 760 millimetres. The high-pressure cylinder is fitted with Corliss valves, and the remaining cylinders with poppett valves, and the four cylinders may be connected so as to provide simple, compound, or triple expansion, as desired, the power for the triple expansion arrangement being 100 h. p. The engine is arranged to be operated with steam superheated to 270° C., and the clearance and receiver volumes may be altered at will to enable experimental studies upon such variations to be made.

In addition to the experimental steam engine, the laboratory is equipped with a department for gas engines, including two experimental gas engines, a gas generator and apparatus for testing and measuring the gas, while in other rooms are steam pumps, and apparatus for researches in hydraulics. The boiler house is equipped not only with the steam generating plant for the laboratory, but also with appliances for boiler testing and for the study of fuels and firing.

It is not our intention, in calling attention to this recent laboratory, to enter into a detailed description of its equipment, but rather to use it is an occasion to discuss the great importance of technical laboratories in general. Formerly testing either of machines or of materials was conducted solely for commercial purposes, being intended either to maintain the standard of product, or to enforce the provisions of specifications and contracts. Such testing, while doubtless most useful, was rarely available for purposes of education or of original research, and the expense of systematic testing precluded its adoption in industrial establishments for other than the strictest commercial requirements.

With the advent of mechanical laboratories, however, there has been a general advance of the knowledge of the behaviour of materials and methods of use, and the whole status of the work of the constructing engineer has been raised by reason of the mass of original knowledge which has been acquired in these institutions.

Apart from the general educational value of such work, it is possible in the laboratory to investigate problems which have originated in practical work and have been referred to the student and the professor for further elucidation. In such matters the laboratory has proved a most valuable auxilliary to the work of the technical professional society, and much of the research work of committees of such bodies has been performed in the laboratories of institutions in which the active members have been instructors and professors.

One of the most valuable features of such work lies in the publicity which attends the researches, and not the least healthful influence exerted is the banishment of the spirit of secrecy and mystery which formerly surrounded all original work of investigation. When researches involving much expense are undertaken by private establishments there is a disposition to regard the results as something to be kept from competitors, and while this spirit can readily be understood it is none the less to be deplored as tending to retard the progress of the profession at large. The work of the engineering laboratory of the technical school, on the contrary, is made public, in the fullest sense, the apparatus being described and illustrated, and the results published and distributed far and wide, with most beneficial results. It is therefore a subject of congratulation to the profession of engineering at large to note the completion of such departments, and no department of engineering education is more worthy of encouragement and assistance.

Modern Methods of River Regulation.

ALTHOUGH the necessity for controlling and regulating streams has been a necessity almost from the beginning of civilization, it forms a branch of engineering which is probably as unsettled as any which might be named. The conditions are so varying that the practice of one locality necessarily differs from another, and hence the prevalence of empirical methods, and the absence of systematic and scientific study.

Of late years, however, the subject has been given more scientific consideration, and in a recent paper by Herr Ignaz Pollak, published in the *Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines,* the modern methods of river regulation are reviewed and discussed.

The rational treatment of river regulation appeared in a paper presented by M. H. Girardon, at the sixth international congress for internal waterways, held at The Hague in 1894. M. Girardon is a chief engineer of the department of Ponts et Chausées, in charge of the special service of the Rhône and his views are the outcome of the experience gained in this work. This paper was followed by one presented at the eighth international navigation congress at Paris in 1900, by M. Timonoff, professor at the technical institute of St. Petersburg.

The general principle of the modern system is to regulate a river in the true sense of the term, and not to convert it into a canal.

In an unimproved stream all the elements are variable, including volume, slope, velocity, and nature of banks and bed. The earlier methods of regulation sought to render all these elements stable, and so far as possible to make them uniform. The idea was to straighten the channel, and to unify the slope as nearly as possible to its mean value, or at least to control successive sections in this manner and in general to transform the natural regimen of the stream.

The modern system on the contrary, seeks to study the stream in its natural state, to investigate the reasons for its serpentine path, and for the variations in depth, and to establish and maintain a navigable channel by assisting and reinforcing the natural course of the stream, instead of compelling it forcibly to assume a new one.

The winding course so generally found in unimproved streams is by no means accidental, but can in nearly every instance be referred to natural and local causes, which exist and persist in spite of any efforts to overcome them, and which can be enlisted in the work of maintaining a proper channel, if proper judgment is used. Attempts have been made to reduce the paths of river beds to mechanical and geometrical laws, but the conditions are too complicated, and the number of variables too great to enable a satisfactory solution of the problem to be made in this manner. Observation, however, has revealed certain facts, such as the erosion of the bank and bed on the convex side of a bend, determining to a certain extent the position and depth of channel, and the probable modifications of its course.

M. Timonoff reviews the methods of river regulation, as conceived and executed under the earlier ideas of engineers in in all parts of the world. These methods include a determination of a so-called "normal" cross section for the stream, and an attempt, by artificial structures to confine the water to a single channel approximating to this determination. Curves are supposed to be eliminated or modified so far as possible, and the banks protected by quays, levées, and similar works.

Opposed to these are the principles enunciated by Girardon, and expanded by Timonoff. According to Girardon the stream should be guided and regulated in the course which it has already marked out for itself. The true aim of the improvement works should be to prevent the navigable channel from overrunning its natural depth, this to be kept in mind both in the construction of works upon the banks and upon the bed. Improvements for the control of high water flow should be most carefully planned so as to avoid interference with the course of the normal and low-water channel, since it is under the influence of floods and high waters that the greatest deformations have their origin.

The work of Timonoff is based largely upon results obtained in a study of the Volga, while that of Girardon, as already mentioned, is due to his experience in the regulation of the Rhône.

Recent German Shipbuilding.

THE series of able papers upon the development of shipbuilding in Germany, by Herr Haack, which appeared in the pages of this magazine in 1899, gave a general account of the manner in which this important industry has grown in Germany since 1870. That development has since been emphasised by the magnificent products of the Germany shipyards, and especially of the great Vulkan works at Stettin, which have been placed in commission and which have shown by their performances the thoroughness with which they have been designed and constructed.

The Deutschland has already been described and her record-breaking performances are well known. Now this great ship is followed by another from the same yards, and from an account in a recent issue of *Stahl und Eisen,* we abstract some notes about the Kronprinz Wilhelm, the latest triumph of German shipbuilding.

Built for the North German Lloyd, the Kronprinz Wilhelm exceeds her predecessor, the Kaiser Wilhelm der Grosse, both in dimensions and in speed. The new ship is 663 feet long as against 648 for the "Kaiser," the displacements being respectively 21,280 tons, and 20,380 tons. The vessel is divided into 24 water-tight compartments so arranged that any two, even if adjoining, may be entirely filled without danger to the ship. The doors of the compartments are arranged so that they may be closed at night or in time of fog, without seriously affecting the convenience of the passengers, while a system of electric indicators in the chart room shows the officer on watch the position of every compartment door, whether open or closed. The vessel is most completely equipped with electrical appliances of every kind, for lighting, heating, ventilation, and communication.

The propelling machinery consists of two sets of quadruple engines of six-cylinders each, counterbalanced on the Schlick system, and capable of developing 30,000 horse power, the nickel steel propeller shafts being 25 inches in diameter, steam being furnished by twelve double ended and four single ended Scotch boilers, operated at a pressure of 215 pounds per square inch.

Although no official announcement is made of attempts to break records, the fact that the Kronprinz Wilhelm and the Deutschland are in the hands of rival lines, and are the latest products of the same makers, there is every reason to believe that records will be lowered by them at least until another giant structure now under construction shall appear as a still later and greater rival.

Germany now possesses 13 express steamers of speeds between 19 and 24 knots, while the fast liners of the Cunard and White Star companies attain speeds of but 20 to 21 knots. There are also 22 vessels operated by German owners and built in Germany of a displacement exceeding 10,000 tons, while England at present possesses but 20 such vessels. These figures serve to show the growth of German shipbuilding, and the manner in which an industry almost wholly British but a few years ago has become also German.

The Electrical Manufacture of Glass.

THE process of manufacturing glass has undergone several important modifications within recent years, these changes appearing mainly in the methods and apparatus for fusing the mixture of silica and alkalies.

The pot furnace in which a number of clay pots are arranged within a furnace and acted upon externally by the heat from an adjacent grate, has largely given way to the so-called "tank" furnace, the glass being fused in large quantities upon the hearth of a reverberatory furnace. With the introduction of the tank furnace the use of direct firing has been replaced by gas firing, and with this either regenerative or recuperative systems are employed.

The use of the electric furnace is now advocated for the purpose of glass making, and in a recent issue of the *Elektrochemische Zeitschrift* we note an article by Dr. Bermbach, describing the arrangement of furnace for the employment of electric arcs.

In the types of electric furnaces employed for the production of carborundum and calcium carbide, the operation is generally intermittent, a charge of material being placed in the furnace, the terminals adjusted, and the current turned on until the operation is completed, after which the mass is permitted to cool, and removed for a fresh run. Various attempts have been made to construct continuous electric furnaces, especially for the production of calcium carbide, but as yet these are not in commercial and practical service.

Since the temperature of fusion of the materials for glass making is much lower than that required for calcium carbide, or for carborundum, the problem of constructing a continuous furnace is materially simplified. Dr. Bermbach gives the general arrangement of such a furnace, showing how the crushed and mixed material is fed in a continuous stream, the fused glass being drawn off in like manner. The furnace contains three electric arcs, arranged in succession along an inclined plane, each arc having a sort of pocket below it in which the fused mass can collect and overflow to the next one. The crushed materials are fused between the terminals of the first arc, and are more thoroughly mixed in their passage to the second, while the final fusion in the third arc effects to production of the very fluid glass, which is delivered into a collecting pot from which it can be taken at once for manufacture of any desired articles.

It is well-known that when carbon electrodes are impregnated with various salts it is possible to obtain long arcs with currents of comparatively low pressure. In the use of arcs for fusing glass, therefore, the electrodes are prepared with solutions of soda, potash, sodium sulphate, etc., this enabling arcs of 2 to 3 centimetres long to be obtained with a pressure of about 40 volts, and with the arrangement of three arcs above described the current required is about 100 amperes for each of the first two, and 50 amperes for the third arc.

Melted glass is a good conductor, the conductivity varying somewhat for various kinds, and experiments are in progress to determine this point more exactly. Since the glass is electrolytically decomposed by a continuous current, it is necessary to employ alternating currents for the electric glass-furnace.

The important feature in connection with the process naturally lies in the cost, as compared with the older methods. This necessarily depends largely upon the cost of the electric current, but is also affected by the diminished size of the plant. Instead of a large tank, holding a great mass of molten glass, the electric furnace requires but a single pot, into which a small stream of fused glass is continually flowing, as water runs from a pipe, and much of the great expense of erecting and maintaining furnaces, regenerators, gas producers, etc., is avoided. Little or no time is lost in starting, since the great heat of the arc produces an immediate fusion of the powdered materials, and hence the operation may be started and stopped at any time, by the mere turning on or off of the electric current and the flow of material.

An interesting feature of the method appears in the fact that it renders glass-making possible in localities where the high price of fuel is prohibitory, but where water power is available for the generation of electricity.

The Optical Study of Metallic Surfaces.

We have noticed elsewhere the researches of M. Frémont upon the brittleness of steel and other metals, showing conclusively that tension tests alone are insufficient to permit the true strength of a metallic structure to be determined.

Supplementing these researches comes an important study by M. Vinsonneau, published in *Le Revue Technique,* extending the work of M. Frémont by showing the possibility of determining with a fair degree of accuracy the character of a piece of material by an optical examination of its surface.

This method appears to be especially applicable for the detection of molecular changes in a material after it has been in use for some time, and is beginning to feel the effects of the stresses to which it has been subjected.

M. Cornut has expressed very clearly the manner in which the molecular condition of a material may become changed by the application of external forces.

If we suppose a piece of steel or iron to be subjected to a continuous stress, slowly and gradually applied, it can readily be understood that such a persistent stress will be transmitted successively from molecule to molecule, in such a manner that all the molecules of the body will become subjected to the same stress. If, on the contrary, the stress is suddenly applied, we can understand that sufficient time is not given for the distribution of the stress, and hence the molecules which are first impressed may be disarranged before the stress can be transmitted to the others. It is therefore altogether possible that materials may be affected very differently when subjected to slow or to sudden stresses.

Now the experiments of Frémont have shown very clearly the manner in which a nick or break in the surface of a bar will permit it to break very readily under a blow if the metal is at all brittle. The narrower and sharper the nick the more readily will the rupture occur, while a smooth and shallow depression does not appreciably affect the strength.

It is naturally most important that pieces which are to be subjected to heavy or sudden stresses should be most carefully inspected at the time of their manufacture in order that any surface cracks may be detected. At the same time a piece may be entirely free from visible cracks and yet contain internal cracks which the effects of alternating stresses, or changes of temperature bring to the surface.

It is possible to see some such cracks by the unaided eye, but these are less dangerous than the minute indications of interruption of continuity which can only be revealed by a closer examination. The value of such optical inspection is more to be realised when the effects of high speeds are understood. Such pieces, as the crank, crank-pin, connecting-rod, and piston-rod of a steam engine may be entirely free from injury at moderate speeds, while at higher speeds the formation of cracks and liability to breakage is greatly increased.

The care with which the surfaces should be scrutinized necessarily depends much upon the character of the machine and its work. For the operative parts of a marine engine or of a dynamo, or a modern high-speed engine of large power a very careful scrutiny is desirable. The nature of the defects which may be revealed under a magnifying glass should convey valuable information to the experienced eye. Thus the fine lines, indicating incipient cracks, may be either longitudinal or transverse, while their form may also show where weakness or possible fracture may develop.

The importance of such indications naturally depends much upon the material in which they are seen. As M. Frémont has shown, a test piece may give high results under tension, while the drop test upon a nicked bar will reveal a high degree of brittleness. Such a material becomes uncertain with the slightest appearance of any surface cracks. With a material which has given a high result under the drop test, however, much more security may be felt. M. Vinsonneau gives an example of the examination of the tubes of a Belleville boiler in a case of a mysterious rupture. Here a careful inspection of the surfaces revealed cracks, produced probably by vibration and by expansion and contraction strains, rendering the metal altogether unreliable.

Other examples, such as the piston-rod of a steam hammer, and similar subjects exposed to shock and vibration are cited to show the entire feasibility of inspecting important pieces from time to time, and obtaining ample warning of coming fractures in time to prevent serious accidents.

In view of the rapid increase in speeds and pressures, and the general high-pressure system of working now becoming so general, it is evident that some method of systematic inspection should be adopted if full security is to be maintained. Such a system of optical inspection as suggested by M. Vinsonneau, preceded by careful testing for brittleness, as well as for tensile strength should enable materials to sustain with entire safety, stresses and speed which might otherwise be altogether uncertain.

REVIEW OF THE AMERICAN PRESS

Modern Naval Engineering.

In examining the report of Engineer-in-Chief Melville, of the United States Navy, we are impressed with the testimony which it offers to sustain a position which has already been emphasized in these columns; the necessity for a revolution in the control and handling of those fighting machines known as ships of war.

It was Captain John Ericsson, we believe, who first described a war ship as a fighting machine, and it was Ericsson's Monitor which first showed the naval powers that henceforth fighting on sea at least was to be done by machinery. The lesson is one which has been but slowly learned, notwithstanding the thoroughness with which all the skill of engineer and machinist has been impressed into the work of construction. The manner in which the fine fighting machines possessed by Spain were mismanaged at Santiago is negative testimony, at least of the uselessness of putting such vessels into the hands of any but engineers.

The enactment of the personnel bill for the United States Navy was intended to increase the efficiencv of the engineering department of the service. At least that was the ostensible reason for its enactment. The real reason, as is well understood, was to put an end to the controversy between the line and the staff officers, and the act was intended to require all officers to be qualified both for the deck and the engine room.

As Mr. Melville clearly points out, the bill has failed of its purpose, simply because the great majority of the officers prefer the deck to the engine room, and because the act contained no provision for the alternation of duty between the two stations. The success of the personnel bill depended entirely upon the manner in which it was interpreted, and the controlling influence which made possible the passage of the bill was expressed by the then Assistant Secretary Roosevelt's statement: "Every officer on a modern war vessel has to be a fighting engineer."

The present is rightly regarded as an age of engineering. A modern battleship is a floating fort, filled with complex machines whose efficient care and maintenance should only be intrusted to a trained mechanical force, and the best efforts of this force can be obtained only when directed by trained officers.

It is not sufficient, however, to assume that trained engineer officers are needed in connection with the management of the propelling machinery only. They are really a necessity in every portion of the ship, and there is to-day practically no department in which a working knowledge of engineering is not required. Under these circumstances the personnel bill is all right; it needs only to be fully and determinedly executed. It will not do to introduce a number of warrant machinists to run the machinery, and to permit the men who have been educated at the expense of the government for the purpose of doing the work of the government to shirk their responsibility because, forsooth, they do not like engine room work.

Some day some one of the great naval powers will awaken to the fact that fighting by machinery means also fighting altogether with engineers, and by engineering methods alone, and will sweep the whole mediaeval system overboard, and equip a fleet with a grim lot of men in overalls, who will run a warship as if it were a machine shop. There will be no frills about uniform or rank or precedence, except so far as is necessary for organization and management; no disputing about credit or glory or any other ancient fiction. A warship will be an ugly piece of machinery built to kill men and smash things, and the men who do the work will do it for the wages they get just like any other workmen. The whole miserable business of warfare will appear in all its ugliness, divested of all its glamor, as a horrible necessity, to be deplored if you like, but to be done mechanically and unimpassionately, just as Homestead rolls its rails and beams, and as Duquesne feeds its blast furnaces with ore and coke.

The nation which first attacks the war problem as a mechanical business, and turns it over, not to its Miles, and Corbins and Sampsons and Schleys, but to its Carnegies, its Morgans, its Fricks for managers, and to men like Corliss, Fritz, Baldwin, Jones, Hunt, Waring, Sweet,—engineers who know what to do and how to do it—that nation will have revolutionized warfare in the true sense, and made the great stride towards its abolition.

So long as fighting is considered a thing to be admired, to be associated with glory, popularity, social distinction, and personal adornment with uniforms and decorations, so long will it persist in all parts of the world as an honorable profession, to be the aim of many and the admiration of more. When, however, it is made entirely a mechanical performance, when the personality is taken out of it as wholly as in the case of modern automatic tools, when the identity of the performers in a conflict is as thoroughly concealed as it is now in every ordinary manufacturing operation, there will be fewer candidates for the training schools in the art of war, and fewer occasions for the exercise of the art itself.

Slag Cements.

THERE has been so much discussion as to the true commercial and industrial status of cements made from slag, that the paper of Professor W. K. Hatt upon tests of American slag cements, given in the *Proceedings of the Indiana Engineering Society,* is most welcome. In order to start right Professor Hatt proceeds to define the meaning of the term slag cement, as well as the present meaning of Portland cement.

A Portland cement, commonly so-called, is made from either pair of the following raw materials, sufficiently mixed together in a finely divided form:

Compact limestone with from 18 to 20 per cent. of clay;

Chalk and clay;

Marl and clay;

Clay bearing limestone properly dosed with clay or shale, and limestone. This mixture is calcined at a high temperature to nearly the point of fusion. The resultant clinker is ground to a fine powder, and in this condition called Portland cement.

Of late the attempts to utilize the slag produced by iron furnaces has led to its employment in the manufacture of cement. Limestone is used as a flux in the blast furnace, while the iron ore contains the silica and alumina corresponding to the clay elements in the Portland cement. The slag is suddenly cooled, in order to granulate it, after which it is dried and mixed with about one-fourth part of slaked lime, after which the mixture is finely ground to form cement.

"For works requiring an early and final strength, Portland cement is usually specified by the engineer. The attempt to use under such specifications certain cements, called Portland cements, but made from a mixture of slag sand and slaked lime, has led to a dispute. On one side we find ranged those who claim that an essential feature of production of a Portland cement is a calcination, or roasting of a certain artificial mixture of carbonated lime and clay to a clinker, and subsequent grinding to a powder. On the other side we find those who insist that the burning to a cinder of the limestone and other material of the blast furnace furnishes a material which, chemically, is nearly a proper mixture for a Portland cement, and that the subsequent correction by addition of a slaked lime paste does not, from the point of view of a definition, involve an error in the case of those who call this product Portland cement.

"There are two ways of regarding the dispute. First, from the point of view of a descriptive term it is well to have a separate name for the two products which are different in their mechanical and chemical properties. If we desire a sidewalk cement, we should not specify the material by any name which will involve a cement made by the second process above described for slag material, involving no calcination.

"Second. From the point of view of historic origin it has been pointed out that the original patent for Portland cement involved a double calcination; first of the limestone; then of the mixture of this calcined limestone and clay. So, strictly speaking, our modern Portland cements have no right to succession to the term Portland.

"The cements made by the first process have, however, the right of possession to this term Portland. It would then seem the part of wisdom to divide the cements of this country into three classes—natural, Portland and slag.

"Natural will include those made by roasting and subsequent grinding of an argillaceous limestone (a natural mixture of limestone and clay).

"Portland will include those made by calcining to a clinker and then grinding an artificial mixture of the proper proportion of limestone (or marl or chalk, or clay-bearing limestone) and clay (or slag sand). The slag cements will include those made by grinding a mixture of pulverized granulated slag and slaked lime paste, which mixture has been made without applied heat.

"This matter is somewhat important, as at least four brands of slag cements as described above are on the market as Portland cements. To ask for a definite classification is not to find fault with slag cements. They have a distinct and high value for many engineering works. Let engineers write the specifications and manufacturers put out their product on the same nomenclature."

Since 1880 the progress of the manufacture of slag cements has rapidly advanced, and at the present time there are ten mills in France, twelve in Germany, and nineteen in other parts of Europe, as well as four in the United States.

The paper gives the results of a number of very careful tests made at Purdue University under the direction of Professor Hatt, these being fully tabulated and also plotted in graphical diagrams. The interested reader must be referred to these for details, but a few general features may be given here.

"The appearance of the slag cement is characterized by a delicate lilac color, in some cases almost white. When cement is made from slag by a process involving roasting, the cement is of a dark color like that of ordinary dark colored Portland.

"It has not the coarse or gritty feeling which characterizes most Portland cement. It works fast, sets slowly and passes ordinary tests for permanence of volume.

"A pat of the cement exposed to the air has to be well covered to prevent the surface from cracking. After drying out, it will exhibit discolorations, yellowish or brown, whereas the pat hardened under water will not exhibit such discolorations. The characteristic color of the fracture of a water-hardened briquette is green, but when the briquette dries out the fracture becomes white. The writer has noticed this green color, with a subsequent change to white, in the case of a well-known American Portland cement, and also the discolorations in the pat, indicating slag adulteration or else a not sufficiently oxidizing flame in the kiln. The green color is due to the presence in slag cement of sulphide of iron. This sulphide becomes oxidized on exposure to the air and changes color. Slag cements contain usually from 0.5 to 1.5 per cent. of sulphides.

"It is this tendency to oxidation on exposure to the air, which is destructive to mortar made of slag cements containing an excess of sulphides and makes it necessary to use the product in underground situations or the interior of thick walls. A parallel test of briquettes hardened in air and water should be made to check up presence of sulphides. This disintegration does not occur in case of all slag cements; it is not a necessary defect.

"Time of Set.—The European slag cements which set finally in six or eight hours seem to be more slowly setting than the American cements, which take their final set under the one-pound needle in from one to three hours.

Strength.—The mechanical strength of the slag cements under tension and compression is quite favorable, although not all equal to that of the better grade of Portland cements. The writer obtained for one of the best of these American slag cements a strength of somewhat above 550 pounds per square inch at the end of the year.

"In case of Portland cements, quick lime exists after burning and grinding; and air-slaking or aging is required. Often these Portland cements are sent out too new, the lime being masked temporarily by sulphate of lime. Since in case of slag cements the lime is completely hydrated, no such danger exists of blowing or swelling, and they are said not to need any 'aging.' They are also said not to deteriorate on storage."

Slag cements evidently have their own proper place in engineering work, and their use should be encouraged whenever they are available, since they offer an excellent method of utilizing an otherwise waste product.

There need be no quibbling about names, since every engineer should specify a cement by its properties, not by name, and should require the standard he desires to be met by systematic and rigid tests, regardless of trade names or maker's reputations.

High-Frequency Electrical Oscillations.

In a very interesting address recently delivered before the Western Society of Engineers, and published in the *Journal* of the society, Mr. Arthur V. Abbott presented a good account of the effects of high-frequency electrical oscillations, and in a general way made some of the possibilities of high pressure oscillations clear.

After some general discussion of the nature of oscillations, exemplified by the pendulum of a clock, Mr. Abbott proceeds to show that in every electrical circuit there are four quantities which claim attention; first, the force present in the form of electricity, second, the resistance which is encountered in transporting the electricity from place to place; third, the electrical inertia, or inductance, the property which demands time for the transfer of electricity; fourth, the capacity of a circuit to contain an increasing amount of electricity with increasing pressure.

At every moment after a definite amount of electrical force has been impressed upon a circuit, it is found that the quantity of energy dissipated as heat, plus that stored in the magnetic field around the circuit, is exactly equal to the original quantity, and that if the electrical pressure be removed, the magnetic field and the capacity give up and restore the energy they have absorbed. This is a complete analogy to the original mechanical illustration of the pendulum.

After a number of lecture-room experiments to illustrate resistance, impedance, and capacity, Mr. Abbott proceeds to show some of their effects. In general it may be said that resistance acts to dissipate electrical energy, while inductance and capacity operate to store up and retain the energy in such a manner as to permit it to be subsequently recovered. Curiously also, inductance acts in a manner opposed to capacity. When a circuit is electrified, inductance acts in a manner opposed to motive force that opposes the transfer of electrical energy, while on the other hand capacity acts as an elastic electrical tank that courts an inrush of current.

Mr. Abbott describes an arrangement by which these properties may be utilized to produce electrical oscillations of high pressure and frequency, and with this apparatus some remarkable phenomena may be produced. Taking the 110 volt continuous current from the Edison service mains and passing it through a rotary transformer, an alternating current of the same voltage is obtained, and with a frequency of 133 periods per second. This current then goes to a static transformer, which raises the pressure to 10,000 volts. Across the leads from the transformer is placed a condenser, composed of sheets of tinfoil immersed in oil, and from the condenser the circuit passes to the primary of a high-frequency coil, being interrupted by a spark gap of five aluminum balls, this giving every opportunity for adjustment and variation.

This arrangement permits the production of discharges between the terminals of the high frequency coil with a pressure of about 200,000 volts, and a frequency of 178,000 to 616,000 per second.

The effects of such a system are similar to those of static electricity produced by the largest Holtz machine. With the very high frequency sparks no longer pass between the terminals, but instead each pole emits a violet brush which envelops it in a pale flame shooting a foot or more into the air. Sparks may be drawn to the finger with perfect safety, for owing to the high frequency there is no sensation. A glass plate placed between the terminals does not stop the sparks, as in the case of an ordinary induction coil; on the contrary there is a network of sparks spread over the surface of the plate, which is soon pierced. Many curious phenomena similar to nodes and loops of vibrating solids are produced, and vibrations may be set up in exhausted tubes without the use of any connecting wires or terminals. The number of experiments and illustrations of the effects of such oscillations is unlimited, but they all go to give a deeper insight into the fundamental constitution of the universe than has been previously possible.

The atomic theory of Dalton assumed that matter was resolvable into a comparatively small number of different elements incapable of further analysis by any process. Physically each element could be reduced to particles of very minute yet perfectly appreciable dimensions, valled atoms, while an attempt to subdivide the atom would, if it could be conceived of as successfully result in its destruction at least in the material sense.

"Recently it has been shown that by electrically acting upon many of the elements in the gaseous state it is possible to split up the so-called atoms into portions that are from 1,000 to 2,000 times smaller than all preconceived ideas indicated possible. Such bodies have now received the name of corpuscles, and we are further confronted with good evidence that the corpuscles obtained by electrical analysis from different elements exhibit the same physical properties, or, in other words, that corpuscles obtained from hydrogen are the same in all respects as those obtained from oxygen. This leads to the very startling proposition that in an ultimate analysis there is only one kind of matter, and that the whole physical universe is but a vast phantasmagoria of Protean changes, wrought by one fundamental form of force, acting on a basic form of matter."

The Performance of Air Brakes.

THERE is probably no one more important factor in the improvement of railway speeds than the general introduction of modern continuous brakes. Those who remember the loss of time involved in the operation of the old-fashioned hand brakes realize this very fully, while a parellel to the old-time conditions for passenger trains has been found until recently in the handling oi freight trains.

The present conditions in the practice of railway air brakes were well brought out in a paper recently presented before the New York Railroad Club by F. M. Nellis and some extracts will show the close relations of efficient air-brake performance to economical transportation.

Mr. Nellis affirms that the railways in the eastern states are behind those of the far west in air-brake maintenance, and urges the necessity for more thorough inspection.

"Should a close investigation be made of air-brake doings in testing and repair yards, roundhouses and shops, a large number of roads would find that their machine of air-brake practice and maintenance is working at very low efficiency. What is first and more needed than anything else, perhaps, is a candid recognition of the fact that the air-brakes in freight train service to-day are not receiving the attention they should.

"An honest appreciation of this condition, and an organized and systematic effort to better look after the road practice and air-brake maintenance will result in a wonderfully improved showing, as well as increased safety and a better movement of trains in heavy traffic.

"What are we to do to better our air-brake service which we are so candidly informed is not up to the highest standard? Procure the services of a first-class general air-brake inspector, give him full authority in everything pertaining to air-brakes, and hold him responsible, having him report directly to the Superintendent of Motive Power or the General Superintendent. The first and most important qualification of a general air-brake inspector is that he must be a leader, a man of character and ability, and competent to handle men. He should know the manufacturers' method of building brakes, etc. He should know the best designs for applying brakes to locomotives and cars, and know how to steer the drawing room away from the faulty ones. He should be thoroughly conversant with the construction and operation of brakes, train handling, and yard and shop repairing. He should be able to give proper and thorough instructions in the operation, inspection and repairs of all parts of the air-brakes. If he is supplied with an instruction car fitted up with air-brake material for instructing employees, he should put in alternate weeks in the car instructing, and on the road about the shops and yards, giving practical illustrations and object lessons. He should know all that is going on in the air-brake line over the entire road, in all of the shops, offices and drawing rooms."

Mr. Nellis gives some very interesting accounts of the value of quick wit, and common sense in engineers in connection with air-brake difficulties, and shows how a loose joint or a defective washer may delay a train. Such care, however, should not be necessary with proper inspection. Inspection alone, however is not sufficient to insure entire reliability, and a convenient and efficient testing department should be equipped, and constantly used.

"A portion of the yards where freight and passenger cars lie before being made up into trains should be arranged with piping, suitable valves, etc., for testing the brakes on these cars while they are lying idle, and not wait until the train has been made up, engine coupled on and ready to depart. A large number of the principal railroads have installed such plants in both their passenger and freight yards.

"In addition to the yard testing plant there should be arranged suitable repairing facilities where brakes may be repaired when found to be in need. Tracks at loading sheds and freight houses, also other places where cars are stood for loading, should be piped so the brakes on those cars may be inspected and tested while the cars are being loaded."

The efficient performance of air brakes is largely dependent upon the care exercised in applying them, and this is of even more importance on long freight trains than on passenger trains. The best results are obtained by using two applications of the brakes in making a stop,—the first being a heavy application to check the speed of the train, and the final application, a lighter one, to bring the train to a standstill. Uniform adjustment of piston travel is another feature which should not be overlooked, and this, together with an automatic slack adjuster, will go far to give prompt and effective train control.

Wooden Pavements.

A RECENT paper before the American Society of Municipal Improvements, by Mr. F. A. Kummer, gives an interesting review of the past history of wooden pavements in the United States, with some suggestions as to future developments.

Three distinct phases marked the past use of wood pavements in American cities.

"The first step was an improvement on the corduroy road. It converted a mudhole into a passable way. The round or hexagonal blocks were not treated, consequently they rotted. They were one-third sap wood, consequently they rounded quickly on the edges. They were highly unsanitary because they absorbed street filth. They sank into ruts and holes because they had no foundation; but they were cheap; they eliminated the mud hole, and in that way served a good purpose.

"It occurred to some enterprising genius to improve this pavement by squaring the blocks and dipping them in tar. This form of pavement, generally known as the Nicholson block, was extensively laid in many cities to their great and lasting sorrow. Why anyone should have anticipated success with such a pavement is almost incomprehensible. In the first place, little or no care was taken in the selection of the timber; hard and soft, heart wood and sap, seasoned and unseasoned, all woods looked alike to the promoters of the pavement. A dipping in hot coal tar or pitch served to cover up the defects, and incidentally to seal up within the wood the moisture due to lack of seasoning, thus hastening dry or heart rot as much as possible. The introduction of laths between the blocks served to make large joints, and thereby to admit as much water as possible under the pavement. Sometimes the pavements rolled in billows like the sea. At this stage they were generally thrown away. The use of untreated planks on earth as a foundation was ingenious in its insufficiency. That part of the pavement that was not heaved up by the frost, went down by the rotting of the planks.

"As a third phase, creosoted wooden blocks on a proper concrete foundation have begun to be laid in a few places throughout the country. This is really a wooden pavement."

The manner in which properly constructed wood pavements will sustain a heavy traffic is shown by the behaviour of the pavements in Paris and London. In the rue de Rivoli in Paris the traffic is eight times heavier than on Fifth avenue or Madison avenue in New York, and the wear is only one centimetre per year. Equally good results are had in London, and the traffic there is the heaviest in the world, including, as it does, the heavy omnibus lines.

The foundation for every kind of pavement should be first-class concrete, and hence there is no reason why this should be especially prescribed for wood pavements, it should be insisted on as a necessity.

"In constructing a perfect wooden pavement, two methods of treating the surface of the concrete may be adopted. It may either be covered with a very thin cushion of clean fine sand, not exceeding one inch in thickness, and thinner if the upper surface of the concrete will admit of it, or it may be floated with a grout of Portland cement and fine sand, mixed thick and brought to a true surface and grade by the use of a template, as in the case of a sand cushion. If the latter method is used, the blocks may either be set in the wet surface of the grout, and lightly tamped or rolled, or the grout may be allowed to harden and its surface be slushed with a coating of pitch or asphaltic cement, such as is often used in grouting joints with brick or granite block. Into this coating, while hot, the blocks should be set, and tamped or lightly rolled, as before. The blocks should be set as closely together as possible, both in the direction of the street and from curb to curb, and rammed tight every few courses. By laying the courses at an angle to the curb line, say thirty degrees, better results will be secured, as there is much less chance for the calks of horses' shoes to round off the edges of the blocks. After being laid the joints should be partially filled with very fine, clean sand, and the pavement rolled. A much heavier roller may be used with advantage where a sand cushion is used. The Boston pavements above referred to were mostly rolled with a 15-ton roller, and no damage whatever was done to the blocks. With bricks this would not have been the case. After rolling the joints should be fully filled with pitch or a good asphaltic cement.

Such a grout should be poured over the entire surface of the street and be swept into the joints with a wire broom. The surface of the street, after grouting, should be spread with a coating of fine, sharp sand, making a practically perfect roadway."

Mining in Mexico.

In view of the limited amount of scientific information available concerning the mining and metallurgical industries of Mexico, the very full paper by Dr. Joseph Struthers, in a recent issue of the *Engineering and Mining Journal* is a welcome addition to the stock of knowledge of that country. As Dr. Struthers remarks, apart from a few articles scattered through the papers of scientific societies and in the technical press, no attempt has been made to discuss in a systematic manner the mineral resources of this important country. Both under the native dominion and under the later Spanish rule Mexico has stood pre-eminent in the production of both gold and silver, and while untold wealth has been extracted from her many mines, there yet lies stored in the lower levels of operative mines, as well as in unexplored regions a vast quantity of precious and base metals.

Dr. Struthers begins with a description of the general geology of Mexico, and then takes up the various mining districts.

The mining regions follow the direction of the Sierra Madre range and extend from Oaxaca in the southeast to Sonora in the northeast, a distance of 2,574 kilometers of a general width of 402 kilometers. The richest mines so far discovered lie in the South Central Plateau, of from 1,370 to 2,900 meters elevation above the sea level. Probably the richest known argentiferous region in the whole world is on a line drawn from Oaxaca on the south, through Guanajuato to Guadaloupe, Chihuahua, on the north. Accor ing to official reports for the year 1900, there are 1092 mining districts in the republic, of which 553 are silver or silver-lead propositions, 237 gold mines and placers, 141 coal, petroleum, etc., 68 cinnabar, 41 copper, 36 lead and 16 tin, and during 1898 to 1899 taxes were paid on existing lodes to the number of 8,970, covering an area of 84,557 hectares.

"The mineral resources of Mexico are so vast in amount that the republic may be considered one of the richest mining countries in the world, and while the metal-bearing districts have been exploited during the past 400 years by innumerable mining enterprises and immense quantities of precious metals have been extracted, a great part of her mineral wealth still lies undisturbed, awaiting the application of modern methods of mining and treatment. Under the favoring conditions of railroad extension and influx of foreign capital and labor, Mexico will be placed in the foremost rank of the metal-producing countries of the world. Early in the nineteenth century Humboldt estimated the number of mines in Mexico to reach 3,000 and while many have been idle during recent years, the extension of railroads bringing remote regions into close communication has caused a revival of interest in the mining industry. In spite of imperfect methods of extraction, lack of proper transportation, inefficient labor and other drawbacks, Mexico has already produced more than one-third of the total output of silver in the world.

"Gold occurs in Mexico chiefly in Sonora on the slopes facing the Pacific Ocean near the gold-bearing regions of California, and its production from this source will probably be largely increased, especially since the Yaqui Reservation has been thrown open to the public. In Guerro and in Oaxaca as well, considerable gold is produced from shallow placers and from the crude arrastra treatment of ores, and in other districts deposits of this type have been reported. The precious metal also occurs in many silver ore deposits, principally in the State of Zacatecas. A number of old mines which have been closed down for years are being unwatered and placed in repair and with modern methods of working, the shafts will be extended to greater depths with advantage to the development of the mining industry. There are also immense heaps of tailings resulting from the primitive methods of ore treatment that are of sufficient value to yield a profit when worked by modern methods.

Dr. Struthers gives interesting data concerning the output of copper, lead, quicksilver and coal, and takes up each mining district in detail, giving accounts of the mines, smelters and transportation facilities. American enterprise has done much to develop these properties, and with the introduction of methods from the United States we may expect to see the mining and metallurgical industries of Mexico make rapid progress.

Electric Traction Stations in New York.

In a recent issue of the *Street Railway Journal* the great power stations of New York are discussed and criticised by Mr. William Kent, and some interesting points are brought out.

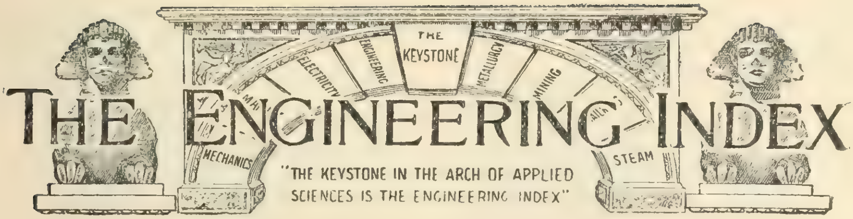
In the first place, although the conditions are very similar in all cases, the practice does not seem yet to be fully unified. Thus although all three of the great stations of New York are situated with an ample supply of water, the methods of condensation of steam differ, one using surface condensers, and another jet condensers, with separate condensers for each engine, while the third employs the central system to the extent of using a jet condenser for each four engines. The water available for condensation is not suitable tor feed, being salt or brackish, and the use of jet condensers involves the additional cost for city water for boiler feed, but it has been maintained that this is preferable to the return of the condensed steam, with its entrained oil, to the boilers. Clearly there is a field for oil separators and filters here.

Mr. Kent believes that higher economy might be attained by the use of higher steam pressures, superheating, and higher rotative speed, but it must be remembered that in such stations there are other things besides steam economy which must be considered.

Above all things unfailing certainty of operation and freedom from breakdowns must be given first place, and this means that the highest degree of simplicity is desirable.

It has been clearly shown that in a great power station the cost of fuel is about one-half the total cost of the power, so that any mere saving in fuel does not mean a corresponding proportional reduction in the total cost of power. If the saving is made at the expense of an addition to the fixed or operative charges it may prove a dear bargain, and it has often been found that an economy in steam is not an economy in money.

The modern power house, like all great undertakings, is a compromise between many conflicting conditions, and as such it must be considered as a whole rather than in detail.



THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCES IS THE ENGINEERING INDEX"

The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) When published,
(6) Where published.

We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Bridges in the Pan-American Exposition Grounds. Illustrated description of the method of constructing 30-ft. timber highway arches. 800 w. Eng Rec—Oct. 26, 1901. No. 43884.

The Elastic Arch (Sur la Voute Elastique). G. Poisson. A mathematical discussion of the general theory of the elastic arch subjected to a hydrostatic load. 1000 w. Comptes Rendus—Sept. 16, 1901. No. 43933 D.

The Luxemburg Stone Arch Viaduct. Illustrated description of a masonry highway arch having a centre span of 275½ ft., the longest span of its kind now in existance. 1000 w. Eng Rec—Oct. 12, 1901. No. 43771.

The Rockville Bridge of the Pennsylvania. C. W. Hardt. Illustrated description of an imposing bridge nearly completed, costing nearly $1,000,000. 1200 w. R. R. Gaz—Oct. 25, 1901. No. 44016.

Brooklyn Bridge.

An Expert Report on the Improvement of the Brooklyn Bridge Terminals. Report of a board of engineers, with editorial comment. 5500 w. Eng News—Oct. 17, 1901. No. 43816.

The Brooklyn Bridge—Its Defects and Treatment. George S. Morison. Discusses the design of the bridge, and the proper remedy for the defects. 1000 w. R. R. Gaz—Oct. 18, 1901. No. 43819.

The Brooklyn Bridge—Its Defects and Treatment. Joseph Mayer and Edwin Duryea, Jr. A letter stating the reason why they did not advise replacing the whole superstructure of the bridge. 1100 w. R R Gaz—Oct. 25, 1901. No. 44015.

The Brooklyn Bridge. Report of the engineers appointed to examine the bridge and report its exact contdition. 9000 w. Ir Age—Oct. 10, 1901. No. 43683.

The Manhattan Terminal of the Brooklyn Bridge. Extracts from the report of a board of engineers, with editorial comments. Ill. 5400 w. R R Gaz—Oct. 18, 1901. No. 43820.

The Physical Condition and Safety Under Present Loads of the New York and Brooklyn Bridge. Report by Edwin Duryea, Jr. and Joseph Mayer, engineers appointed to investigate the safety of the bridge, with editorial comment. Ill. 30000 w. Eng News—Oct. 10, 1901. No. 43742.

Cincinnati.

Mill Creek Bridge, Cincinnati, O. Illustrates and describes details of a plate-girder through bridge about 80 ft. high. The two main girders are 213 ft. long over all, giving a clear span of 199 ft. between abutments. 1000 w. Eng Rec—Sept. 28, 1901. No. 43520.

Design.

Excessive Refinement in Bridge Design. Discusses features of design in recent German bridges which were tried and abandoned in the United States 20 years ago. 1100 w. Eng Rec—Oct. 26, 1901. No. 43883.

Some Thoughts Concerning Changes in Bridge Design. Editorial discussion of experience in regard to iron bridges and discussing also the cost of a masonry arch and points in its construction. 3000 w. Eng News—Sept. 26, 1901. No. 43527.

Draw-Bridges.

A Graphical Method for the Solution of Stresses in the Continuous Girder, as Applied to Draw-Bridges. George F. Barton. Describes this method which is simple and comprehensive, stating some of its advantages. 3500 w. Pro Am Soc of Civ Engrs —Oct., 1901. No. 44000 E.

German Bridges.

Two New German Bridges, with Transverse Articulation and Freely Suspended Floors. Illustrated description of the striking structural features of the recent bridges built across the Rhine at Worms, and across the Elbe at Harburg. 2200 w. Eng News—Oct. 17, 1901. No. 43818.

Military Bridges.

The Cluchagne System of Military Rafts and Bridges. From *La Nature.* Illustrated description. 600 w. Sci Am Sup—Oct. 12, 1901. No. 43740.

Pratt-Truss.

The Northport Bridge. Illustrated description of a combination single-track bridge having spans of 250 and 150 ft. The structure is an interesting example of a type of bridge used only where good wood is plentiful and metal expensive. 1900 w. Eng Rec—Oct. 19, 1901. No. 43837.

Redheugh Bridge.

The Redheugh Bridge, Newcastle-on-Tyne. Many illustrations of the details of an interesting structure between Newcastle and Gateshead, with brief description. 600 w. Engng—Oct. 4, 18, 1901. Two parts. No. 43764 each A.

Substructure.

Methods of Construction of the New Cambridge Bridge Substructure, Boston, Mass. Sanford E. Thompson. Illustrates and describes the pile driving; the cutting off of the piles; the construction of the cofferdams; and the concrete mixing and laying. 3300 w. Eng News—Oct. 17, 1901. No. 43814.

CANALS, RIVERS AND HARBORS.

Amsterdam.

An Account of the Progress of the Improvement of the Public Waterways in Amsterdam (Mededeelingen aangaande de in Uitvoering zijnde Werken voor de Geneetelijke Waterleidingen binnen Amsterdam). J. M. K. Pennink. An address before the Royal Institute of Engineers, describing the works now in progress. 3000 w. De Ingenieur—Sept. 28, 1901. No. 43991 D.

Canals.

Georgian Bay Canals. Discusses its construction from the commercial standpoint and the effects it would have on the trade of the Great Lakes. 4300 w. Marine Rev—Oct. 3, 1901. No. 43630.

The Canals of Canada. Reviews the existing and proposed canals and improvements, and gives reasons why an open water route from the Great Lakes to the sea should be maintained. 2000 w. Builder—Sept. 28, 1901. No. 43648 A.

Charles River.

Geological History of the Charles River. Frederick G. Clapp. An interesting study explaining why the river follows its present course, tracing the great courses, etc. Ill. 8,500 w. Tech Qr—Sept., 1901. Serial. 1st part. No. 43690 E.

Docks.

The Dock at Burnt Island. An illustrated description of a new dock on the Firth of Forth, at an important coal port. 2000 w. Transport—Oct. 18, 1901. No. 44020 A.

Dredge.

Suction Dredge for Harbor at Sabine Pass. Illustrated detailed description of a seagoing twin screw suction dredge to be used for harbor improvement. 1100 w. Marine Engng—Oct., 1901. No. 43624 C.

Dry-Dock.

Dry-Dock Foundation at Kiel, Germany, Laid from a Floating Caisson with Compressed Air. Brief illustrated description. 400 w. Eng News—Oct. 10, 1901. No. 43745.

Estuaries.

Marine and Estuarine Deposits. Prof. W. B. Scott. Lecture at the Wagner Inst., Philadelphia. An interesting description of these deposits in shallow and deep waters. 4000 w. Sci Am Sup—Oct. 12, 1901. No. 43741.

Harbor Improvement.

Description of Coos Bay, Oregon, and the Improvement of Its Entrance by the Government. L. M. Haupt. Continued discussion of paper by William W. Harts. 1800 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43507 E.

Description of Coos Bay, Oregon, and the Improvement of Its Entrance by the Government. Continued discussion of paper by William W. Harts. 6700 w. Pro Am Soc of Civ Engrs—Oct., 1901. No. 44002 E.

Irrigation.

Extensive Project for Irrigating Egypt. Briefly outlines the works at present under construction and their cost, and also the projects under discussion. 1200 w. Sci Am—Oct. 12, 1901. No. 43734.

Types of Irrigation in the West. George Ethelbert Walsh. An interesting review of irrigation projects established in various parts of the western States, and their results. 3400 w. Gunton's Mag—Oct., 1901. No. 43634 C.

Light-Houses.

Improved Rapid Group Flashing Lights. Alan Brebner. Read before the Glasgow Congress. Mainly a description of Brebner's eclipsing mechanism for lighthouses. Ill. 2000 w. Engng—Oct. 18, 1901. No. 44025 A.

River Improvement.

Improving Rivers in China. Concerning the improvement of the Peiho and Whangpoo rivers, with the regulations. 2500 w. U. S. Cons Repts, No. 1149—Sept. 30, 1901. No. 43510 D.

Modern Methods of River Regulation (Ueber Neuere Flussregulierungs-Methoden). Ignaz Pollak. A review of the latest Continental practice involving the study and maintenance of the natural bed of the stream. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 4, 11, 1901. No. 43944 each B.

The Regulation of River Beds at Railway Crossings (Verruiming en Vernauwing van hel Rivier bed bij Spoorwegovergangen). A. B. Marinkelle. Describing especially the manner in which the channel of the Maas has been regulated at the bridge at Buggenum, Holland. 3500 w. De Ingenieur—Sept. 14, 1901. No. 43990 D.

The Regulation of the Oppa at Jägerndorf (Die Oppa-Regulierung in Jägerndorf). M. Kohut. With map and section, showing the construction of dikes for controlling the channel of the river Oppa, as it passes through the town of Jägerndorf, Bohemia. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 27, 1901. No. 43943 B.

Sluice Gates.

Great Sluice Gates of the Nile Irrigation Works. Brief illustrated description of the device employed. 700 w. Sci Am—Oct. 12, 1901. No. 43735.

Zuider Zee.

The Drainage of the Zuider Zee (Desséchment du Zuider Zée). A review of the latest plans for the recovery of successive portions of the Zuider Zee as provided in the scheme now before the government of Holland. 1500 w. Revue Technique—Sept. 25, 1901. No. 43929 D.

The Zuider Zee. An outline of the scheme for enclosing this large area of the sea and reclaiming the land. 1200 w. Engr, Lond—Sept. 27, 1901. No. 43640 A.

CONSTRUCTION.

Building Details.

Girders in the Colonial Building, Boston. Illustrates and describes unusual steel work details in a large theater. 1300 w. Eng Rec—Oct. 12, 1901. No. 43775.

Exposition Buildings.

External Color of the Pan-American. Charles H. Coffin. A critical discussion of the color scheme introduced in the buildings. Ill. 1899 w. Br Build—Oct., 1901. No. 44041 D.

The Buildings of the Glasgow International Exhibition, 1901. James Miller. Brief illustrated descriptions of the principal buildings. 1100 w. Jour Roy Inst of Brit Archts—Sept. 28, 1901. No. 43855 B.

The Buildings of the Louisiana Purchase Exposition. A general outline of the architectural scheme at the St. Louis fair. 700 w. Eng Rec—Oct. 26, 1901. No. 43,893.

Foundations.

Earth Movements, Underground Water and Foundations. Extract from letter of Mr. Somers Clark, concerning the condition of St. Paul's Cathedral, London. Also discussion of the subject by Dr. G. Johnsone Stoney. 2800 w. Stone—Aug., 1901. No. 43567 C.

Pneumatic Caisson Foundations of the New York Stock Exchange Building. An illustrated detailed description of very interesting and rapid work, showing new methods of excavation. 4000 w. Eng Rec—Sept. 28, 1901. No. 43519.

Framework.

The Stresses in Compression Members of Simple Framed Beams (Die Berechnung der Spannungen in den Pfosten einfacher Fachwerkbalken). A. Ostenfeld. An analytical examination for various conditions of loading. 1000 w. Zeitchr d Ver Deutscher Ing—Oct. 5, 1901. No. 43,906 D.

Grain Elevator.

The New 3,100,000-Bushel Steel Grain Elevator for the Great Northern Ry., at West Superior, Wis. Description and illustrations of the construction and equipment. 2700 w. Eng News—Sept. 26, 1901. No. 43526.

India.

The Periyar Dam and Irrigation Works, Southern India. A full presentation of this important engineering work, its plan and purpose, construction, material, power plant, etc. Ill. 7500 w. Eng News—Oct. 24, 1901. No. 44010.

Roofs.

Steel Armory Roofs. H. G. Tyrrell. Facts relating to steel roofs that will be of assistance in securing an approximate estimate of the amount of steel in a proposed roof. 900 w. Archts and Builds Mag—Oct., 1901. No. 43670 C.

The East Orange Town Hall Roof. Illustrated description of an unusual type of wooden roof truss. 500 w. Eng Rec—Oct. 26, 1901. No. 43891.

The Tremont Church Roof, New York. Illustrated description of unusual pointed hingeless arch trusses for a 73x95 ft. auditorium. 1100 w. Eng Rec—Oct. 19, 1901. No. 43839.

Subway.

Moving a Long Brick Wall. Illustrated description of the method of enlarging a section of the New York Rapid Transit Railway subway by moving back the retaining walls. 800 w. Eng Rec—Oct. 26, 1901. No. 43887.

The New Subway in New York City. Charles Prelini. Reviews the various proposals for rapid transit, and begins an illustrated detailed description of the work now in progress. 3200 w. Engng—Oct. 4, 1901. Serial. 1st part. No. 43762 A.

Tarnsey Act.

Building Construction Under the Tarnsey Act and Suggestions for Modifying It. William A. Boring. Suggestions based on the author's experience in connection with the immigrant station on Ellis Island, N. Y., for remedying the defective features of the law governing the work of architects employed on national buildings. 3500 w. Eng Rec—Oct. 26, 1901. No. 43890.

Tunnels.

The Simplon Tunnel. Illustrates and describes the works in progress on the northern or Swiss side of the mountains. 2400 w. Engr, Lond—Sept. 27, 1901. No. 43642 A.

The Walworth Street Sewer Tunnel, Cleveland. Illustrates and describes difficult construction work in building a tunnel under the tracks of the Big Four R. R., through very soft, wet ground. 1000 w. Eng Rec—Sept. 28, 1901. No. 43521.

Warehouses.

Grain Warehouses in Russia (Les Magasins à Blé en Russie). G. Espitallier. Describing especially the large warehouses at Nikolaieff, on the Black Sea, and at Windau on the Baltic. 2000 w. 1 plate. Génie Civil—Sept. 21, 1901. No. 43914 D.

MATERIALS.

Buckling.

The Theory of Buckling (Zur Theorie der Knickfestigkeit). Alois Schneider. A discussion of the various formulas from the time of Euler to the present, with a mathematical treatment of the elastic theory. Two articles. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 27, Oct. 4, 1901. No. 43941 each B.

Cement.

Possibilities for Portland Cement manufacture on the Pacific Coast. A. H. Cederberg. Discusses the situation, cost of plant, etc. 1100 w. Min & Sci Pr—Oct. 12, 1901. No. 43812.

The Rotary Kiln Process of Cement Manufacture. William Harry Stanger and Bertram Blount. Abstract of a paper presented to the Inst. of Civ. Engrs., with editorial. An exposition of the theory and practice of this process and of the adaptability and economy of the rotary kiln. Ill. 14400 w. Eng News—Oct. 24, 1901. No. 44012.

Cement-Making.

The New Plant of the Alpha Portland Cement Company at Alpha, N. J. Illustrated description of a plant having ten rotary kilns. The various processes of manufacture are described successively and the special features of the plant, particularly the conveying apparatus. 2800 w. Eng Rec—Oct. 5, 1901. No. 43657.

Ceramics.

Ceramics versus Stone in Architecture. Reprint of an article from *La Ceramique,* concerning the employment of ceramics, and the reasons why they are not popular with architects. 1400 w. Stone—Aug., 1901. No. 43568 C.

Concrete.

Some Primary Causes of Expansion and Contraction in Portland Cement Concrete and Mortars. H. Howard Humphreys. Examines in detail the causes that produce disruptive stresses and disintegration. 3800 w. Builder—Oct. 5, 1901. No. 43,-750 A.

The Advance of Concrete Construction. An illustrated description of the new car shops at Elizabethport, N. J.; all the buildings, with one exception, are being constructed with concrete walls, and some have the roof of concrete also. 1400 w. Ir Age—Oct. 3, 1901. No. 43569.

Mortar.

Note on the Consolidation of Mortar. George W. Rafter. A record of tests made by the writer. 500 w. Pro Am Soc of Civ Engrs—Oct., 1901. No. 44001 E.

Reinforced Concrete.

Cement-Iron Construction (Cement-Ijzerconstructies). L. A. Sanders. A discussion of the Hennebique, Monier, and other systems, with especial reference to bridge construction. 3000 w. De Ingenieur—Aug. 24, 1901. No. 43995 D.

Some Examples of Concrete and Expanded Metal in Municipal Structures. Illustrated description of concrete-steel work in the foundations of pavements for water conduits and for outlet sewers. 1200 w. Eng Rec—Oct. 26, 1901. No. 43886.

Tests of Concrete and Concrete-Iron Construction (Zeber Versuchsergebnisse bei Erprobung von Beton und Beton-Eisen Constructionen). J. A. Spitzer. With data and results of a number of tests of beams, plates, etc., including diagrams of loads and deflections. 5000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Oct. 11, 1901. No. 43945 B.

Use of Steel in Concrete Construction. Illustrated description of forms in which this material is used. 900 w. Sci Am Sup —Oct. 12, 1901. No. 43738.

MUNICIPAL.

Drainage.

The New "Drainage By-Laws" of the London County Council. A review of the by-laws recently adopted. 3200 w. Builder—Sept. 28, 1901. No. 43649 A.

Garbage Crematory.

The Decarie Garbage Crematory at Minneapolis. Illustrated description of the incinerators which are essentially a modification of water-tube boilers. 900 w. Eng Rec—Oct. 5, 1901. No. 43659.

Pavements.

Pavement Guarantees. George W. Tillson. Paper read before the Am. Soc. of Munic. Engr. on the different classes of guarantees and the best form of each. 3900 w. Eng Rec—Oct. 12, 1901. No. 43778.

Recent Experience with Wood Pavements. Extracts from a paper by B. T. Wheeler describing pavements in Boston of pine blocks treated by the creo-resinate process. 2300 w. Eng Rec—Oct. 5, 1901. No. 43661.

The Improvement of Streets and the Wood Pavements of Paris (Die Strassenbefestigung insbesondere das Holzpflaster in Paris). Alexander Swetz. A comparison of the cost and advantages of stone, wood, asphalt and macadam for street pavements, with especial reference to the wood block pavements of Paris. Serial. Part I. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 11, 1901. No. 43946 B.

Wooden Pavements at Home and Abroad. Extracts from a paper by F. A. Kummer, sketching the history of such pavements and describing the latest types in the United States, France and England. 4000 w. Eng Rec—Oct. 26, 1901. No. 43892.

Public Works.

Changes in the Management of Public Works, New York City. N. P. Lewis. An outline of the administration of public works under the charter taking effect Jan. 1, 1902. 1000 w. Eng Rec—Oct. 26, 1901. No. 43889.

Refuse.

Refuse Disposal in the District of Columbia. Dr. William C. Woodward. Extracts from a paper read before the Am. Pub. Health Assn. Reviews the history of the past ten years in the city of Washington. 3500 w. Eng Rec—Sept. 28, 1901. No. 43525.

Sewage Disposal.

Boston's Sewage Disposal Plant. From the *Boston Transcript.* Descriptive. 2000

w. Dom Engng—Oct. 15, 1901. No. 43832 C.

Papers on Sewage Purification Read Before the Glasgow International Engineering Congress. Abstract of papers and discussions with editorial comment. 5500 w. Eng News—Oct. 10, 1901. No. 43744.

Recent Sewerage Work in Worcester, Mass. Illustrates and describes recent difficult sewerage construction, sewage interceptors, and full notes on the operation of a disposal plant, employing chemical precipitation, intermittent filtration and a septic tank. 3600 w. Eng Rec—Oct. 26, 1901. No. 43885.

Septic Tank and Double Contract Filter Beds for Treating the Sewage of Glencoe. Ill. H. D. Wyllie. Illustrates and describes the works, grit chamber, septic tank, filters, method of working, etc. 800 w. Eng News—Oct. 24, 1901. No. 44,014.

Sewage Disposal at a Leper Asylum. Outlines an interesting and instructive series of experiments carried out at the Matunga Leper Asylum, at Bombay, as given in a recent report by C. C. James. 3500 w. Engr, Lond—Oct. 11, 1901. No. 43,867 A.

The New Sewage Disposal Plant at Madison, Wis. F. E. Turneaure. Read before the Am. Soc. of Munic. Eng. An account of the various methods tried, the plant built and condemned, and a description of the plant in progress of construction, consisting of a septic tank and rapid filter. 3700 w. Eng News—Oct. 17, 1901. No. 43815.

The Septic Tank System at Glencoe, Ill. Illustrated description of septic tanks and filters built to treat 25,000 gallons of sewage daily. 900 w. Eng Rec—Oct. 19, 1901. No. 43838.

The Vancouver, B. C., Septic Tanks. Illustrated description of tanks for treating the sewage before discharging it into salt water. 400 w. Eng Rec—Oct. 12, 1901. No. 43772.

Sewers.

Sewer Ventilation Experiments at Leicester, England. Review of paper by E. G. Mawbey, giving the results of nearly 3000 experiments with different systems of sewer ventilation. 1800 w. Eng Rec—Oct. 12, 1901. No. 43773.

The 14th Ave. Sewer and 60th St. Sewer Tunnel Work, Brooklyn, N. Y. Illustrates and describes interesting sewer work through fine sand carrying considerable water. Also deep manhole construction. 800 w. Eng News—Oct. 10, 1901. No. 43743.

WATER SUPPLY.

Analysis.

Standard Methods of Water Analysis. Second report presented by the Committee to the Am. Pub. Health Assn. Recommends methods to be pursued in physical microscopical and quantitative bacterial examinations. 3600 w. Eng Rec—Sept. 28, 1901. No. 43523.

Belfast.

Belfast Water Supply. An illustrated account of the recent extensions. 2000 w. Engr, Lond—Oct. 18, 1901. No. 44029 A.

Buffalo, N. Y.

The Water-Works System of the Pan-American City. An illustrated description of this fine municipal plant. 1700 w. Sci Am Sup—Oct. 5, 1901. No. 43605.

Consumption.

The Consumption of Water in Municipal Supplies and the Restriction of Waste. Clemens Herschel. Continued informal discussion of this subject. 1700 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43503 E.

The Consumption of Water in Municipal Supplies and the Restriction of Waste. A continuation of the informal discussion on this topic. 4000 w. Pro Am Soc of Civ Engrs—Oct., 1901. No. 44005 E.

Cuba.

The Water-Works of Guantanamo, Cuba. S. D. Rockenbach. Illustrated detailed account of the work, with particulars concerning the region and conditions to be met. 2500 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43501 E.

Eels.

Eels in Water Works and Their Control. Dr. George W. Field. Gives an account of the habits and breeding of eels, and suggests ways of preventing trouble from them in water works. General discussion. 6000 w. Jour N Eng Water Wks Assn—Sept., 1901. No. 43697 F.

Electrolysis.

Electrolysis of Water and Gas Pipes, Resulting from Electrical Currents Escaping from Street Railways. Edwin P. Mathews. Read at the Central States Water-Works Assn. Refers especially to conditions in Dayton, Ohio, but the remarks are of general application. 3400 w. Fire & Water—Oct. 12, 1901. No. 43765.

Filtration.

The Lawrence, Mass., City Filter: A History of Its Installation and Maintenance. Continued discussion of paper on this subject by Morris Knowles and Charles Gilman Hyde. 11300 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43,504 E.

Fire Protection.

The Apportionment of Charges for Private Fire Protection, and the Means of Controlling the Supply for Such Service. Topical discussions, and report of committee appointed to consider this subject.

1600 w. Jour N Eng Water Wks Assn—Sept., 1901. No. 43698 F.

Inspection.

The Work of Sanitary Inspection on the Metropolitan Water-Works. William W. Locke. Read before the N. E. Water-Works Assn. Calls attention to the dangers through pollution of the sources of water supply by house and barn drainage, suggesting means of prevention. 2700 w. Eng Rec—Sept. 28, 1901. No. 43522.

Ozone.

The Sterilization of Water by Ozonized Air (Die Wassersterilisierung durch Ozonisierte Luft). F. Krall. A description of the Abraham & Marmier process for sterilizing water for household use. 1500 w. Elektrochem Zeitschr—Aug. 1901. No. 43986 H.

Statistics.

Water Works Statistics for the Year 1900, in Form Adopted by the New England Water-Works Association. Compiled by Charles W. Sherman. 3000 w. Jour N Eng Water Wks Assn—Sept., 1901. No. 43696 F.

Water-Meters.

The Water Meter as a Sanitary Agent. M. N. Baker. Read before the Am. Soc. of Munic. Imp. Discusses the benefits from the use of meters, claiming that they cause purer water supplies, freer use of public water, extension of sewerage systems, and render more money available for sanitary improvements. 1300 w. Eng News—Oct. 10, 1901. No. 43746.

MISCELLANY.

Stresses.

Calculating the Stresses in Hinged Arched Ribs. Charles Lean. Describes a method requiring only the ordinary rules of arithmetic, and providing co-efficients applicable to other ribs of any span, depth or proportion, and amount of live to dead loads. Ill. 2000 w. Engr, Lond—Sept. 27, 1901. No. 43641 A.

Surveying.

A Practical Improvement in Tachymetry (Eine Praktische Neuerung beim Tachymetrieren). S. Wellisch. With especial reference to the reduction of vertical angles to a horizontal plane. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 27, 1901. No. 43942 B.

ELECTRICAL ENGINEERING

COMMUNICATION.

Brussels.

The New Telephone Station in Brussels (Die Neue Fernsprech-Vermittelungsanstalt in Brüssel). A description of the new central telephone station. The glow-lamp signal is used, and the central battery system of the Western Electric Co. of America. 2500 w. Elektrotech Zeitschr—Sept. 12, 1901. No. 43969 B.

Cables.

Modified Blavier Test. Walter J. Murphy. Describes a method affording a means of localizing a fault with minimum assistance at the further end. 1400 w. Elect'n, Lond—Oct. 11, 1901. No. 43,856 A.

Conductors.

A Note on Loaded Conductors. M. I. Pupin. Gives numerical and graphical illustrations relating to the system of the author for reducing the attenuation and distortion of telephonic currents in cables and long land lines. 800 w. Elec Wld & Engr—Oct. 12, 1901. No. 43768.

Induction.

The Prevention of Induction in Telephone Cables (Ueber Induktions-storung in Fernsprechkabeln mit Doppelpaarrig Verteilten Drähten). J. H. West. Showing how the conductors in telephone cables in which there are two pairs of wires may be so arranged as mutually to destroy induction effects. 1500 w. Elektrotech Zeitschr—Oct. 3, 1901. No. 43979B.

Multiplex.

Simultaneous Multiplex and Ordinary Telegraphy on the Same Circuit (Sur l'Emplor Simultané de la Telegraphie Multiplex et de la Telegraphie Ordinaire dans le Même Circuit). E. Mercadier. A discussion of the experiments of Cailho between Paris and Bordeaux. 600 w. Comptes Rendus—Sept. 16, 1901. No. 43934 D.

Repeater.

A New Automatic Telegraph Repeater. Illustrates and describes an invention of Julio E. Cordovez for repeating telegraphic messages both with and without the use of sounders or other receivers at intermediate stations. 1000 w. Sci Am—Oct. 19, 1901. No. 43823.

Space Telegraphy.

Recent Progress in Wireless Telegraphy (Les Derniers Progrès de la Télégraphie sans Fil). An abstract translation of the lecture of Professor Slaby, recently delivered at Charlottenberg, Berlin. 3000 w. Revue Technique—Sept. 25, 1901. No. 43924 D.

Wireless Telegraphy. A summary of progress made by the various nations during the past year. 2500 w. Marine Rev—Oct. 17, 1901. No. 43835.

Telephones.

Making Molds for Telephone Receiver Work. Joseph V. Woodworth. Illustrates and describes molds used in manufacturing imitation rubber or composition goods for various purposes. 900 w. Am Mach—Oct. 24, 1901. No. 43874.

Telephony.

Changing a Magneto Drop to a Central Battery System. Charles L. Goodrum. Illustrated description of the work. 700 w. Elec Wld & Engr—Oct. 5, 1901. No. 43686.

Cross-Talk in Telephone Cables, with Wires Laid Up in Fours. Jul. H. West. From the *Electrotechnische Zeitschrift.* Discusses the reason why cross-talk appears and some means of eliminating it. 1400 w. Elect'n, Lond—Oct. 11, 1901. No. 43857 A.

DISTRIBUTION.

Converters.

A New Method of Obtaining Continuous Currents from Alternating Systems (Ueber ein Neues System der Entnahme von Gleichstrom aus Wechselstromnetzen). F. J. Koch. By the use of a synchronously revolving commutator in connection with storage batteries, alternating currents are conveniently and economically converted. 1500 w. Elektrotech Zeitschr—Oct. 10, 1901. No. 43981 B.

Tests of Synchronous and Asynchronous Converters (Essais de Convertisseurs Synchrones el Asynchrones). Giving data and diagams of trials of both types as built by the Oerlikon works in Switzerland. 1000 w. Génie Civil—Sept. 21, 1901. No. 43915 D.

Improved Leblanc Converter (Neuer Umformer von Leblanc). C. Feldmann. A description of the new converter made by the Helios Company, of Cologne; with a mathematical analysis of its action. 4000 w. Elektrotech Zeitschr—Sept. 26, 1901. No. 43974 B.

Notes on Rotary Converters and Phase-Swinging. W. M. Thornton. On the use of damping coils, explaining their action. 2400 w. Elect'n, Lond—Sept. 27, 1901. Serial. 1st part. No. 43651 A.

Protection.

The Protection of Fire and Police Telegraph Systems from High-Tension Currents and Lightning. Walter M. Petty. Read at the convention of the International Assn. of Munic. Elect'ns. Describes apparatus in use and discusses what is necessary. 5000 w. Fire & Water—Oct. 19, 1901. No. 43843.

Transformers.

See Electrical Engineering, Measurement.

ELECTRO-CHEMISTRY.

Accumulator.

A method for Increasing the Capacity of Accumulators (Ein Verfahren zur Steigerung der Kapacität der Akkumulatoren). C. Heim. An examination of the influence of the increase in temperature upon the capacity of accumulators. 5000 w. Elektrotech Zeitschr—Sept. 26, 1901. No. 43975 B.

Alkalies.

The Electrolytic Production of Caustic Alkalies (Verfahren zur Elektrolytischen Herstellung von Aetzalkali). H. A. Cohn and E. Geisenberger. Description of apparatus for decomposing alkaline chlorides and the production of caustic alkalies and chlorine. 1200 w. Electrochemische Zeitschr—Sept., 1901. No. 43988 H.

Cadmium Cell.

A Cadmium Standard Cell. Henry Tinsley. Illustrates and describes a cell which has been tested and is regarded as fairly satisfactory. 1300 w. Elect'n, Lond—Oct. 18, 1901. No. 44036 A.

Current Distribution.

The Distribution of Current Lines in Elektrolytes (Streuung der Stromlinien in Elektrolyten). W. Pfanhauser. An examination of the manner in which the current flows from anode to cathode in electrolytic baths. 1500 w. Zeitschr f Elektrochemie—Sept. 26, 1901. No. 43985 H.

Electrolysis.

The Electrolysis of Fused Salts. C. C. Garrard. Reviews an article by Prof. Lorenz, giving a sketch of the present position of the investigations at Zürich. 1700 w. Elec Chem & Met—Sept., 1901. No. 43751 A.

Progress.

Electrochemical and Electrometallurgical Industry. John B. C. Kershaw. This introductory article deals with progress in the United States. 2800 w. Elec Rev, N. Y.—Oct. 12, 1901. Serial. 1st part. No. 43783.

ELECTRO-PHYSICS.

Conductivity.

On the Change of Conductivity of Metallic Particles Under Cyclic Electromotive Variation. Prof. Jagadis Chunder Bose. Read before the British Assn. Deals with those substances which show a diminution of resistance, with typical instances of non-recovering and self-recovering substances, describing the peculiarities of their cyclic characteristic curves. 2500 w. Elect'n, Lond—Sept. 20, 1901. Serial, 1st part. No. 43552 A.

Dielectrics.

Recent Investigations upon Dielectric Bodies (Neuere Beiträge zur Naturgeschichte Dielektrischer Körper). Dr. M. von Hoor. An exhaustive study of the various materials suitable for condenser dielectrics, giving details of experiments, and forming a continuation of the author's former researches. Serial. Part I. 4000 w. Elektrotech Zeitschr—Sept. 5, 1901. No. 43976 B.

Heat Effects.

The Effect of Heat on New Varieties of Iron (Glühversuche mit Neueren Eisensorten). Max Mauermann. Data and results of extended experiments upon the effect of heat upon the magnetic properties of irons. 1500 w. Elektrotech Zeitschr—Oct. 10, 1901. No. 43982 B.

Interrupter.

A Simple and Efficient Mercury Jet Interruption for Röntgen Ray Induction Coils. R. H. Cunningham. An illustrated description of a convenient revolving mercury interrupter for use in the primary circuit of a Ruhmkorff coil. 1500 w. Elec Wld & Engr—Oct. 12, 1901. No. 43769.

Magnetic Curves.

Notes on Magnetic Curves. Jesse Pawling, Jr. Gives full solutions of examples 37, 38 and 39, page 51, of *Minchin's Statics,* Vol. 1, fifth edition. 600 w. Jour Fr Inst—Oct., 1901. No. 43692 D.

Magneto-Electricity.

Adaptation to Discovery. James Wilson. Reviews the early work that showed that mechanical motion could be obtained through the forces of magnetism and electricity. 1100 w. Am Mach—Oct. 3, 1901. No. 43585.

Rectifier.

The Theory of the Electrolytic Rectifier. Dr. K. Norden. Advances a complete theory of the modern electrolytic rectifier, developed according to experimental researches. 2700 w. Elec Wld & Engr—Oct. 26, 1901. No. 43899.

Variable Currents.

The Variability of Currents (Sur l'Etat Variable des Courants). A. Petot. An examination of the laws which govern the variability of electric currents opposed by varying resistances. 1200 w. Comptes Rendus—Sept. 30, 1901. No. 43936 D.

GENERATING STATIONS.

Alternators.

The Inductor Alternator. Edward Heitmann. Claims that this type of alternator, when properly designed and constructed, will meet the most severe conditions encountered in the operation of generators of all sizes and types. Ill. 1100 w. Elec Wld & Engr—Oct. 5, 1901. Serial. 1st part. No. 43687.

Dynamos.

Continuous-Current Dynamos. Henry A. Mavor. Abstract of a paper read before the Glasgow Congress, aiming at a standard system of dynamo design and manufacture, with a review of the paper by Claude W. Hill. 4800 w. Elec Rev, Lond—Sept. 20, 1901. No. 43549 A.

Modern Commutating Dynamo Machinery, with Special Reference to the Commutative Limits. H. M. Hobart, Read before the Glasgow Congress. Gives views regarding the continuous current dynamo-electric machine, describing types. Ill. 3500 w. Elec Engr, Lond—Sept. 27, 1901. Serial. 1st part. No. 43654 A.

England.

Walthamstow Electricity Works. Illustrates and describes the buildings, gas plant, gas engines, dynamos, &c. 500 w. Elec Rev, Lond—Oct. 18, 1901. No. 44032 A.

Germany.

Statistics of Electric Plants in Germany (Statistik der Elektrizitätswerke in Deutschland). The usual annual review of the growth of electric stations in Germany, with full tabulated data of all plants. 15000 w. Elektrotech Zeitschr—Sept. 5, 1901. 43968 B.

Hydro-Electric Plant.

The Carbide Works at Flums (Das Carbidwerk Flums). A description of the hydro-electric plant at Flums, Switzerland, for the manufacture of calcium carbide. Four articles. 4000 w. Schweizerische Bauzeitung—Sept. 14, 28, Oct. 5, 12, 1901. No. 43989 each B.

The Plant of the Lehigh Power Company at Raubsville, Pa. Illustrated description of a hydraulic power plant having two turbine chambers, the turbines in the first working under a 33-ft. head, and in the second under an 18-ft. head. 1100 w. Eng Rec—Oct. 5, 1901. No. 43658.

Water-Power Development at Chaudiere Falls, Que. An account of the undertaking with illustrated description of the terials used, etc. 2500 w. Can Engr—Oct., 1901. Serial. 1st part. No. 43575.

Italy.

Great Electric-Power Installations of Italy. Enrico Bignami. Signor Bignami's present paper describes and illustrates the great power plant at Vizzola-Ticino. 3000 w. Engineering Magazine—Nov., 1901. No. 44051 B.

Karlsruhe.

The Electric Plant at Karlsruhe (Das Elektricitätswerk der Stadt Karlsruhe). F. Winawer. A fully illustrated account of the steam and electric plant. A polyphase system, with transformers is used. 2000 w. Elektrotech Zeitschr—Oct. 10, 1901. No. 43980 B.

Paris.

The Malakoff—Les Halles Electric Tramway (Tramway Electrique de Malakoff—Les Halles). An account of a Paris suburban tramway, using overhead trolley without the city, and storage battery within the fortifications, the battery being charged from the line. 1000 w. 1 plate. Génie Civil—Oct. 12, 1901. No. 43921 D.

The Malakoff Power Station (Usine Electrique de Malakoff). Ch. Dantin. Describing an important generating station in the southwestern part of Paris, supplying current to four tramway systems with a total length of 40 kilometres. 2000 w. 1 plate. Génie Civil—Oct. 5, 1901. No. 43918 D.

Power Plant.

The Power Station at Hazneck, Switzerland. Illustration, vertical section and plan of the power house, with detailed description. 2200 w. Eng Rec—Sept. 28, 1901. No. 43524.

Power Stations.

The Influence of Polyphase Apparatus on the Design of Railway Power Stations. J. E. Woodbridge. On the need of modifying the design to suit the electrical apparatus, illustrating the influences by preventing actual designs based as nearly as possible on usual practice. Ill. 3400 w. Elec Wld & Engr—Oct. 5, 1901. Serial. 1st part. No. 43684.

Storage Batteries.

Storage Batteries Located in Power Stations. W. E. Harrington. Read before the Am. St. Ry. Assn. Considers the conditions that will lead to economical results, and the questions to be considered. 2300 w. St Ry Rev—Oct. 12, 1901. No. 43805 C.

Versailles.

Electric Traction on the Invalides-Versailles Line (La Traction Electrique sur la Line des Invalides à Versailles). F. Drouin. Describing especially the power station at Moulineaux, containing nine direct-connected generating sets of 800 kilowatts each. 2500 w. 1 plate. Génie Civil—Sept. 14, 1901. No. 43910 D.

LIGHTING.

Accounts.

Customers' Accounts for Electric Light Companies. S. E. Moore. Read before the Accountants' Assn. Suggestions relating to the accounting department. 2300 w. St Ry Rev—Oct. 12, 1901. No. 43806 C.

Arcs.

On the Resistance and E. M. F.s of the Electric Arc. W. Duddell. Abstract of a paper before the Royal Soc. Gives a résumé of previous work showing the errors, and considers that the testing current must be very small and completed in an exceedingly short time. Describes methods, &c. 2700 w. Elect'n, Lond—Oct. 4, 1901. No. 43753 A.

Photographing the Electric Arc. Prof. A. C. Stone. Notices briefly some points concerning arc light carbons in operation as indicated by direct photographs of the arc itself. 1200 w. Sci Am—Oct. 19, 1901. No. 43825.

Battersea.

Battersea Electricity Works. An illustrated description of an English electric-lighting installation. 3300 w. Elec Rev, Lond—Oct. 4, 1901. No. 43755 A.

Legal Relations.

The Relation of Electric Light Companies to Municipalities from a Legal Standpoint. D. L. Gaskill. Selections from a paper read before the Ohio Elec. Lgt. Assn. Considers the relations under the headings of franchises, contracts for lighting, private lighting and right of way on public streets as affecting private property. 2800 w. Elec Rev, N. Y—Oct. 5, 1901. No. 43613.

Photometry.

See Electrical Engineering, Measurement.

Stoke Newington.

Stoke Newington Lighting. A report by R. E. Crompton on the lighting of Stoke Newington by electricity, with editorial. 3000 w. Elec Engr, Lond—Oct. 18, 1901. No. 44034 A.

MEASUREMENT.

Electrical Energy.

The Determination of Electrical Energy (Zur Wertbestimmung Elektrischer Kraft). O. Schmidt. An estimate of the energy stored in calcium carbide. Also a discussion of the generation of gas by electricity in localities poor in coal. 1200 w. Zeitschr f Elektrochemie—Aug. 1, 1901. No. 43983 H.

Galvanometers.

On Galvanometers of High Sensibility. C. E. Mendenhall and C. W. Waidner. An illustrated account of an instrument possessing advantages as regards convenience and ease of manipulation, giving results of some experiments with minute magnets. 3400 w. Am Jour of Sci—Oct., 1901. No. 43588 D.

Instruments.

The "Pierre de Plan" Station of the Electric Plant at Lausanne (Apparatenanlage in der Centrale und Umformerstation "Pierre de Plan" des Elektricitätswerke der Stadt Lausanne). K. P. Täuber. Describing especially the measuring instruments and their mounting and connections. 3500 w. Elektrotech Zeitschr—Oct. 3, 1901. No. 43978 B.

Photometry.

An Improved Apparatus for Arc-Light Photometry. Charles P. Steinmetz. Describes an equipment, designed by the writer, for the Photometric Laboratory of Purdue University, which is in satisfactory operation. Ill. 2300 w. Trans Am Inst of Elec Engrs—Aug.-Sept., 1901. No. 43801 D.

An Improved Apparatus for Arc-Light Photometry. Abstract of a paper by Prof. Matthews, read before the Am. Inst. of Elec. Engrs., with editorial comment. Describes and illustrates the equipment, explaining its operation. 2200 w. Elec Wld & Engr—Oct. 5, 1901. No. 43688.

Standards.

Standards for Testing Electrical Machinery (Normalien zur Prüfung von Elektrischen Maschinen und Transformatoren). The preliminary report, presented at the Dresden meeting of the German Electrotechnical Association, for tentative use for one year. 3500 w. Elektrotech Zeitschr—Sept. 19, 1901. No. 43972 B.

Transformers.

Graphical and Experimental Determination of the Drop of Pressure in Transformers (Graphische und Experimentelle Bestimmung des Spannungsabfalles in Transformatoren). O. S. Bragstad. A comparison of the graphical method with direct experimental measurements, showing the practical accuracy of the former. 3000 w. Elektrotech Zeitschr—Oct. 3, 1901. No. 43977 B.

Voltameter.

The Voltametric Balance (Die Voltametrische Wage). W. Pfanhauser. The cathode is suspended from one arm of a balance, and the disturbance of equilibrium indicates the deposit of metal. 1000 w. Zeitschr f Elektrochemie—Oct. 10, 1901. No. 43984 H.

POWER APPLICATIONS.

Cotton Mill.

Power Plant of the Olympia Cotton Mill. Illustrated detailed description. 3200 w. Engr, U S A—Oct. 15, 1901. No. 43795.

Electric Crane.

A 150-Ton Electric Crane. Illustrated description of the powerful hoisting apparatus installed at the entrance of the new repair basins of the port of Bremerhaven, 36 miles below Bremen. 800 w. Sci Am Sup—Oct. 19, 1901. No. 43826.

Lifting Magnets.

Electric Lifting Magnets. Illustrates and describes the device for handling plates at the New York Shipbuilding Company's yard, at Camden, N. J. 900 w. Sci Am—Oct. 26, 1901. No. 43876.

Mining Plant.

Electricity in Gold Mining. Prof. Wilbar Colvin. Illustrated description of the plant of the Crown Mountain Gold Mining Co. of Dolonega, Ga., in which electricity is the motive power throughout. 1400 w. Sci Am—Oct. 5, 1901. No. 43603.

Trade Dollar Consolidated Mining Company's Electric Plant, Snake River, Idaho. Illustrated description of a water-power development that has proved very successful. 2000 w. Sci Am—Oct. 5, 1901. No. 43601.

Pumping.

Possibilities and Limitations of Electric Pumping. Lewis A. Hicks. Presented at convention of the Pacific Coast Elec. Trans. Assn. Sketches briefly the more important uses of electric power in this connection in California, making comparative statements as to efficiency of performance. Also discussion. 6000 w. Jour of Elec—Sept., 1901. No. 43792.

TRANSMISSION.

Climate.

Climatological Influences and Electrical Transmission. Prof. Alexander G. McAdie. Read at convention of the Pacific Coast Elec. Trans. Assn. Discusses the effect on insulators, generators, lines, switchboards, and the whole plant. Ill. 3300 w. Jour of Elec—Sept., 1901. No. 43791.

Long Distance.

The 142-Mile Electric Power Transmission Plant of the Bay Counties' Power Company, California. J. D. Galloway. Illustrated description of a plant using a pressure of 40,000 to 60,000 volts. All the general features are discussed, especially the remarkable manner in which the current is carried across the Straits of Carquinez, 2000 w. Eng News—Oct. 3, 1901. No. 43665.

Mexico.

The Electrical Transmission of Energy at San Ildefonso, Mexico (Transports Electriques d' Energie de la Compagnie de San Ildefonso à Mexico). E. Pinson. Describes the hydro-electric stations at Monte Alto and at Tlalnepantla, with details of the pipe lines and of the transmission. 3500 w. Génie Civil—Oct. 12, 1901. No. 43920 D.

Niagara Falls.

The Electric Transmission of Power from Niagara Falls. Lewis B. Stillwell. An illustrated history of the plant and results obtained. 29000 w. Trans Am Inst of Elec Engrs—Aug.-Sept., 1901. No. 43798 D.

Russia.

A Proposed Water Power Electric Transmission Plant for St. Petersburg, Russia. Brief account of the project for the development of extensive water powers near St. Petersburg with electrical transmission to that city. 1100 w. Eng News—Oct. 24, 1901. No. 44011.

MISCELLANY.

Blue Printing.

Blue Printing by Electric Light. S. B. Whinery. Gives illustrated descriptions of the two types of machines for this purpose now on the market, discussing the advantages of each. 4000 w. Pro Engrs' Club of W. Penn—Oct., 1901. No. 43808 D.

Comparative Practice.

A comparison of American and British Methods. Notes on American Electrical Engineering practice as seen from an English point of view. 2000 w. Elect'n, Lond —Sept. 20, 1901. No. 43551 A.

Expositions.

Electrical Installation and Decorative Work in Connection with Exposition Buildings. Luther Stieringer. Read before the Am Inst of Archts. Describes particularly the electric installation at the Pan-American Exposition. 1700 w. Eng Rec —Oct. 12, 1901. No. 43781.

The Glasgow International Exhibition. Sydney F. Walker, An illustrated account of the electrical features. 5200 w. Elec Rev, N. Y—Oct. 12, 1901. No. 43782.

Fire Protection.

Electrical Exhibits at the Fire Protection Exposition (Die Elektricität auf der Feuerschutz-Ausstellung). F. Wilking. Describes electric fire alarms, pumps and other apparatus shown at the Berlin Exposition. 2000 w. Elektrotech Zeitschr—Sept. 19, 1901. No. 43970 B.

Glass Making.

The Electrical Manufacture of Glass (Die Herstellung von Glas auf Elektrischem Wege). Dr. Bermbach. Describing a form of electric furnace adapted for glass making. 2500 w. Elektrochem Zeitschr—Sept., 1901. No 43987 H.

Lightning.

The Protection of Buildings from Lightning. Killingworth Hedges. Read before the Glasgow Congress. Considers the protection usually inadequate, discusses modern practice, American practice, the protection of Westminster Abbey, &c. 6800 w. Elec Engr, Lond—Sept. 27, 1901. No. 43653 A.

Standardization.

The Standardization of Electrical Apparatus. J. T. Broderick. Mr. Broderick's second paper deals with the utility, convenience, and economy of standardization to the purchaser of electrical apparatus. 3500 w. Engineering Magazine—Nov., 1901. No. 44050 B.

GAS WORKS ENGINEERING

Address.

Inaugural Address Before the North of England Gas Managers' Association. Matt. Dunn. An interesting address discussing coal prices, coke sales, conveyors, the gas of the future, coke-ovens, and other important subjects. 7500 w. Jour Gas Lgt—Oct. 8, 1901. No. 43809 A.

Auditing.

Auditing Gas Works Accounts. The present article discusses the function of the auditor principally and the value of efficient auditing. 2700 w. Jour Gas Lgt—Oct. 15, 1901. Serial. 1st part. No. 44040 A.

Blast-Furnace Gas.

Use of Blast-Furnace Gas in Explosion motors. From *Le Génie Civil.* Summary and discussion of the important work of Herr Lürmann. Ill. 3000 w. Sci Am Sup—Oct. 5, 1901. No. 43606.

Calcium Carbide.

Some Notes on Calcium Carbide Manufacture. Reviews an article by M. G. Pradon, of Paris, recently published in the *Zeitschrift fur Calciumcarbid Fabrikation.* 1400 w. Elec Rev, Lond—Sept. 20, 1901. No. 43550 A.

Carbonization.

The Improvement in Carbonization During Recent Years. E. W. Smith. Read before the Eastern Counties' Gas Mgrs. Assn. Also discussion. Gives results at Chelmsford, and considers needed improvements. 4500 w. Gas Wld—Oct. 5, 1901. No. 43748 A.

Gasholder.

Design of the Proposed Gasholder for Amsterdam (De Constructie van een Outworpen Gashouder voor Amsterdam). J. von Rossum du Chattel. With details of strain diagrams, and special construction to avoid a deep pit in water-bearing ground. 3500 w. De Ingenieur—Sept. 21, 1901. No. 43992 D.

Gas Producer.

Down-Draught Gas Producer (Gazogène à Combustion Renversée). J. Deschamps. A description of the Fangè gas producer, especially adapted for the combustion of wood. 1500 w. Génie Civil—Sept. 14, 1901. No. 43912 D.

Great Yarmouth.

Coal Unloading and Stoking Machinery at Great Yarmouth Gas Works. W. J. Carpenter. An illustrated account of the system introduced, and the results. 3000 w. Gas Wld—Oct. 5, 1901. No. 43747 A.

Growth.

Gas versus Electricity. Alton D. Adams. Gives a comparison of the incomes of these systems, discussing their relative growth during the last ten years. 2300 w. Elec Wld & Engr—Oct. 26, 1901. No. 43898.

Lewis Thompson.

Lewis Thompson and the Early Days of Gas Lighting. A review of the important work of this distinguished chemist. 5500 w. Jour Gas Lgt—Oct. 15, 1901. No. 44039 A.

Retorts.

Further Notes on Retort House Practice. E. H. Earnshaw. Read at meeting of the Am. Gas. Lgt. Assn. Suggestions in regard to the operation of the new and improved methods of coal gas manufacture. 7000 w. Am Gas Lgt Jour—Oct. 21, 1901. No. 43842.

Switzerland.

Results of a Year's Working of the New Gas Works at Zurich, Switzerland. Walter S. Allen. Gives results obtained in the first year's workings of the new plant, as taken from the annual report for the year 1900. 800 w. Am Gas Lgt Jour—Sept. 30, 1901. No. 43518.

Water Gas.

Carburetted Water Gas (Le Gaz a l'Eau Carburé). J. Laverchère. A general study of the generation of water gas beginning with the original apparatus of Gengember in 1819 and continuing to the latest devices. Serial. Part I. 3000 w. Génie Civil—Oct. 12, 1901. No. 43922 D.

INDUSTRIAL ECONOMICS

Australia.

Australian Federation and the British Manufacturer. Stafford Ransome. Points out the difficulties of a satisfactory business with Australia, how some have been removed, and how those remaining may be. 4400 w. Engr, Lond—Oct. 18, 1901. No. 44026 A.

Brazil.

Opening for American Coal in Brazil. A letter from Mr. Castello Branco concerning the opportunity for starting a trade in American coal, giving particulars of points necessary to success. 1800 w. U S Cons Repts, No. 1155—Oct. 7, 1901. No. 43627 D.

Cost Keeping.

The Proper Distribution of the Factory Expense Burden. A. Hamilton Church. Mr. Church's fifth paper is devoted to factory and mass production, and the new machine rate. 3500 w. Engineering Magazine—Nov., 1901. No. 44054 B.

Patents.

The Development and Defects of the American Patent System. C. H. Duell. Extracts from a report by Commissioner of Patents, giving a historical sketch of American practice. 3500 w. Eng Rec—Oct. 26, 1901. No. 43894.

United States vs. German Patent Office Practice. Discusses some of the more obvious differences in the two systems, and the advantage of an understanding to prevent litigation. 2000 w. U. S. Cons Repts, No. 1150—Oct. 1, 1901. No. 43511 D.

Railway Economics.

British Railway Economics. Editorial review of the officially drafted balance-sheet recently issued. 2100 w. Engng—Oct. 11, 1901. No. 43861 A.

Economics of Railway Improvements. W. W. Colpitts. The object of the paper is to outline methods by which the most economical results may be obtained in operation, and to define a basis upon which the yearly value of railway improvements may be quickly and accurately estimated. 6500 w. Can Soc of Civ Engrs. (Adv proof)—Oct. 24, 1901. No. 44047 D.

Strikes.

The Lesson of the Steel Strike. A review of the strike, condemning the leader of the Amalgamated Assn, and commend-ing the attitude of the managers of the U. S. Steel Corporation, and pointing the lessons it has taught. 2500 w. Gunton's Mag—Oct., 1901. No. 43633 C.

Works Management.

The Engineering Management of Industrial Works. William D. Ennis. A review of the advances which have been made in industrial management, showing that the best equipment for the executive is found in technical training. 2500 w. Engineering Magazine—Nov., 1901. No. 44055 B.

MARINE AND NAVAL ENGINEERING

Coal Fleets.

The Ohio River Coal Fleets. H. C. Fithian. An illustrated account of the methods of handling the vast quantities of coal distributed via the Ohio River to the West and South. 3000 w. Marine Engng —Oct., 1901. No. 43625 C.

Cobra.

The Cobra Disaster. Discusses this disaster which occurred on Sept. 17, and caused loss of life, and also discusses the construction of this class of vessels and their requirements. 1800 w. Prac Engr—Oct. 11, 1901. No. 43852 A.

The "Cobra" Disaster. Editorial discussion of the verdict of the court-martial, and of this class of vessels. 3700 w. Engng—Oct. 18, 1901. No. 44023 A.

Coast-Lighting.

Lighting of the Chinese Coast. J. R. Harding. Abstract of a paper read before the Glasgow Congress. Brief outline of what has been accomplished. 1000 w. Engng—Sept. 20, 1901. No. 43558 A.

Recent Improvements in the Lighting and Buoying of the Coasts of France. Baron Quinette de Rochemont. Read before the Glasgow Congress. Illustrates and describes recent improvements in burners, discussing means of increasing the illuminating power, the electric lights, incandescent lighting, light-ships, beacon towers, etc., etc. 7000 w. Engng—Sept. 20, 1901. No. 43557 A.

Cruiser.

The Russian 25-Knot Cruiser Novik. A critical discussion of the value of this class of vessels, with illustrations. 2000 w. Engr, Lond—Oct. 11, 1901. No. 43,-868 A.

Hulls.

Hull Weights. George Crouse Cook. A practical scientific method of classifying and recording this all important item of ship design, by which the weights of a proposed vessel may be estimated quickly and accurately. 1500 w. Naut Gaz—Oct. 17, 1901. No. 43841.

Ice Yacht.

How to Build a Champion Ice Yacht. H. Percy Ashley. Illustrated detailed description of the construction of the "Aurora." 2800 w. Rudder—Oct., 1901. No. 43655 C.

Propellers.

Propellers for Power Boats. Ernest W. Graef. Some ideas concerning propellers and their proportions relative to the motor, hull, etc. 1800 w. Rudder—Oct., 1901. No. 43656 C.

Reconstruction.

The Reconstruction of the Turkish Battleship "Mesoudie." Illustrates and describes interesting work being carried out at Genoa. 600 w. Engng—Oct. 11, 1901. No. 43863 A.

Report.

Admiral Melville's Report. Advance abstract, the notable features being the statement concerning the failure of the personnel bill, and recommendations in favor of Government participation in a series of important engineering experiments. 3000 w. Ir Age—Oct. 24, 1901. No. 43872.

Salvage.

Salvage Case. Judgment delivered in the Victorian Vice-Admiralty Court with respect to the claim against the owners of the Steamship Alala for £6000 for salvage of that vessel and cargo on the 24th of April. 2800 w. Aust Min Stand—Sept. 12, 1901. No. 43854 B.

Salving of the Steamship Willamette. Illustrates and describes interesting work in salving a vessel when the hull was broken in two parts. Many difficulties were encountered, but it finally left under its own steam. 1900 w. Marine Engng—Oct., 1901. No. 43623 C.

Schooner.

A Seven-Masted Steel Schooner. Illustration and description of a vessel constructed throughout of steel. The vessel is propelled entirely by sails, but has a considerable installment of machinery, steam power being used for the hoisting of anchors and sails. 800 w. Sci Am—Oct. 19, 1901. No. 43824.

Scuttling.

Some Facts Concerning the Scuttling of

Ships. Lawrence Irwell. Gives several cases of scuttling and the relation to insurance. 2500 w. Marine Rev—Oct. 17, 1901. No. 43834.

Sheathing.

The Question of Sheathing War Vessels. Harry Phelps. Notes showing the opinions abroad; discussing the advantages and disadvantages of sheathing, etc. 2500 w. Naut Gaz—Oct. 10, 1901. No. 43770.

Shipbuilding.

The Development of Ship and Engine Building (Streifzüge durch das Gebiet des Schiff-und Schiffmaschinenbaues). A review of shipbuilding on the Clyde in connection with the Glasgow Exhibition. Two articles. 600 w. Zeitschr d Ver Deutscher Ing—Sept. 14, Oct. 12, 1901. No. 43901 D.

Steamships.

A New Triumph of German Ship-building (Ein Neuer Triumph der Deutschen Schiffbaukunst). A description of the new steamer "Kronprinz Wilhelm," of the North German-Lloyd Steamship line. 1500 w. Stahl und Eisen—Oct. 1, 1901. No. 43952 D.

Shipping.

Foreign Competition in Shipping and Ship-building. An interesting article showing progress made in the different countries, giving diagrams and tables. 3000 w. Engng—Sept. 27, 1901. No. 43,-635 A.

Shipping Bounties.

German Shipping Bounties. Editorial discussion of the policy of Germany as shown in a recent report made by W. Ward. 2400 w. Engng—Sept. 20, 1901. No. 43556 A.

Steam Traffic.

Steam Traffic and Trade on the Upper Yangtse. J. Mobsby. Gives a review of all that has been accomplished by steam navigators above Ichang, proving that steamers can descend the rapids, but that it cannot be a commercial success. Suggests means of encouraging trade, and gives information of the cities. 4200 w. Jour Soc of Arts—Oct. 4, 1901. No. 43,-749 A.

Submarine.

The First Submarine Boat. From *La Nature.* An illustrated account of the "Nautilus," devised by Fulton, and the experiments made with it one hundred years ago. 1400 w. Sci Am Sup—Oct. 12, 1901. No. 43739.

Tank Steamer.

Tank Steamer Deutschland. C. C. Thomas. Illustrates and describes one of the largest steamers carrying petroleum to German ports. 1600 w. Marine Engng—Oct., 1901. No. 43626 C.

Warships.

The Steamboat Equipment of Warships. E. C. Carnt. Read before the Glasgow Congress. Briefly reviews the history of the application of steam for warship purposes. 3500 w. Engng—Sept. 20, 1901. No. 43559 A.

Warships and Mathematics. Explains a mathematical method of classifying warships. 1900 w. Engr, Lond—Oct. 18, 1901. No. 44027 A.

Yachts.

American Steam Yachts and Their Design. Theodore Lucas. Reviews the principal features of these yachts, the types being classified as fast, medium and slow. Ill. 2000 w. Naut Gaz—Oct. 3, 1901. No. 43667.

Yacht Races.

Fifty Years of "America" Cup Contests. Reviews the contests between the yachts of England and America which have taken place during the last fifty years. Ill. 3300 w. Sci Am—Oct. 5, 1901. No. 43604.

The 1901 Contest for the "America" Cup. An illustrated account of the close contest. 1600 w. Sci Am—Oct. 12, 1901. No. 43737.

MECHANICAL ENGINEERING

AUTOMOBILES.

Burners.

Gasoline and Kerosene Burners. Joseph W. Jones. Advocates the use of petroleum for the purpose of generating heat in steam vehicles, and discusses the defects of the burners now used. 1200 w. Horseless Age—Oct. 16, 1901. No. 43830.

Construction.

Heavier Construction. Hugh D. Meier. Advocating the heavier construction of automobiles and explaining the advantages. 1300 w. Horseless Age—Oct. 16, 1901. No. 43831.

Endurance Run.

Endurance Test Results. Extracts from the committee report. 2000 w. Auto Mag—Nov., 1901. No. 44048 C.

The Endurance Test. Full illustrated account. 8000 w. Auto Mag—Oct., 1901. No. 43610 C.

Explosive Mixtures.

Some Explosive Properties of Gasoline

and Air Mixtures. E. C. Oliver. An account of experiments made imitating as nearly as practicable the conditions existing in the cylinder of a modern gas engine. 1200 w. Horseless Age—Oct. 23, 1901. No. 43873.

Flash Boilers.

The Flash Boiler for Automobiles. Joseph W. Jones. Discusses the advantages of this boiler, and predicts great possibilities, especially in automobile work. 2000 w. Horseless Age—Oct. 2, 1901. No. 43612.

Gasoline Car.

General Specifications for a Gasoline Motor Car. H. Ward Leonard. Gives twenty requirements. 1000 w. Elec Rev, N. Y.—Oct. 5, 1901. No. 43614.

Glasgow Trials.

The Automobile Trials at Glasgow. Alexander F. Sinclair. An account of the five daily runs, the vehicles entered, etc. Ill. 2500 w. Auto Mag—Oct, 1901. Serial. 1st part. No. 43875 C.

Light Car.

The Eastmead-Biggs Voiturette. An illustrated description of a new light car of English manufacture. 1100 w. Autocar—Oct. 12, 1901. No. 43851 A.

The Georges Richard Automobile. Illustrated description of a new type of light automobile of the voiturette class. 700 w. Sci Am Sup—Oct. 26, 1901. No. 43879.

Motor.

The Packard Carriage Single-Cylinder Motor. Hugh Dolnar. Illustrates and describes the leading features of Packard's general arrangement of driving and controlling elements, and the claims of the patent are explained. 4000 w. Auto Mag —Nov., 1901. No. 44045 C.

Newport Races.

The Newport Races. An illustrated account of the races on Aug. 30, 1901. 4500 w. Auto Mag—Oct., 1901. No. 43611 C.

Steam Carriage.

The Reading Steam Carriage. Illustrated detailed description of an interesting car. 1500 w. Autocar—Sept. 21, 1901. No. 43548 A.

Storage Batteries.

Automobile Storage Batteries. Illustrated description in detail of a number of storage batteries designed for automobile work. 5400 w. Elec Wld & Engr—Oct. 5, 1901. No. 43685.

Tour.

A Preliminary New York to Buffalo Tour. S. W. Rushmore. An illustrated account of the run. 2500 w. Auto Mag—Nov., 1901. No. 44044 C.

The 1,000-Miles Tour of "The Powerful." A detailed account of the run made by the "Powerful" electric car from London to Glasgow and Edinburgh. 2500 w. Auto Jour—Oct., 1901. No. 44037 A.

HYDRAULICS.

Flow.

Experiments at Detroit, Mich., on the Effect of Curvature Upon the Flow of Water in Pipes. Discussion of paper by Gardner S. Williams, Clarence W. Hubbell, and George H. Fenkell. 14800 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43505 E.

Experiments at Detroit, Mich., on the Effect of Curvature Upon the Flow of Water in Pipes. Continued discussion of paper by Gardner S. Williams, Clarence W. Hubbell and George H. Fenkell. 4000 w. Pro Am Soc of Civ Engrs—Oct., 1901. No. 44003 E.

Plumbing.

Plumbing in the Connecticut Mutual Life Building, Hartford. Illustrated description of a system in which unusual care has been taken to utilize all waste heat for the warming of water. 1800 w. Eng Rec—Oct. 5, 1901. No. 43663.

Pumping Station.

Pumping Station at the South Works of the Illinois Steel Company. Illustrated description of one of the most extensive pumping stations in the United States connected with an industrial works. 1400 w. Ir Age—Oct. 3, 1901. No. 43571.

Pumping.

See Electrical Engineering, Power Applications.

Pumps.

Pumps at the Paris Exposition, 1900 (Die Weltausstellung in Paris, 1900 Pumpen). M. F. Gutermuth. A general review of the pumping machinery at Paris, with comments on points of novelty and interest. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 12, 1901. No. 43908 D.

Scoop Wheel.

Steam Scoop Wheel at Schellingwonde (Schepradstoomgemaal bij Schellingwonde). H. van Oordt. Illustrated description of large scoop wheels for lifting water about 2 metres for drainage works at Schellingwonde, Holland. 1500 w. De Ingenieur—Sept. 7, 1901. No. 43993 D.

Velocity Measurements.

Current Meter and Weir Discharge Comparisons. Edward C. Murphy. Gives the results of a series of experiments made at the Hydraulic Laboratory, Cornell University, to test the accuracy of velocity measurements obtained with the current meter, used by different methods. 2500 w. Pro Am Soc of Civ Engrs—Sept, 1901. No. 43500 E.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

The Design of Ball Bearings (Beitrag zur Beurteilung von Kugellagern). R. Stribeck. An examination of the proper form of ball race in order to avoid sliding friction. 1000 w. Zeitschr d Ver Deutscher Ing—Oct. 5, 1901. No. 43907 D.

Brass.

Brass Scrap. C. Vickers. Suggestions for the utilization of this material and its treatment. 700 w. Foundry—Oct., 1901. No. 43590.

Castings.

Annealing of Steel Castings. W. M. Carr. Considers such steel as is used in the ordinary branches of the manufacture of castings. Ill. 1000 w. Foundry—Oct., 1901. No. 43589.

Cementation.

The Cementation of Steel and Iron with Gas. C. W. Bildt. From a paper before the Soc. of Swedish Engrs., Stockholm. An illustrated description of the process with statement of advantages. 1600 w. Ir Age—Oct. 3, 1901. No. 43570.

Crane Hooks.

The Strength of Drop-Forged Crane Hooks. John Goodman. An account of tests made of a complete set of crane hooks and the results. Ill. 1600 w. Engng—Oct. 18, 1901. No. 44021 A.

Dies.

Wire Bending and Forming Dies. William Doran. Illustrates and describes work showing what can be accomplished in the bending and forming of comparatively heavy stock in two operations by the use of simple dies. 1000 w. Am Mach—Oct. 3, 1901. No. 43587.

Electric Crane.

See Electrical Engineering, Power Applications.

Flanges.

Standardization of Extra Heavy Flanges. A statement of the dimensions selected for heavy piping in the United States. 500 w. Eng Rec—Oct. 12, 1901. No. 43776.

Foundry Practice.

Iron Foundries and Foundry Practice in the United States. The first of a series of articles giving an illustrated description of the most modern practice in the United States. 2800 w. Engr, Lond—Sept. 27, 1901. Serial. 1st part. No. 43639 A.

Jigs.

A Boring and Facing Jig. Joseph V. Woodworth. Illustrates a jig made for special work. 600 w. Am Mach—Oct. 3, 1901. No. 43584.

Lathe Attachments.

A Multi-Spindle Drilling and Tapping Attachment and Work Fixture, for the Turret Lathe. William Doran. Illustrates and describes designs of the writer. 1600 w. Am Mach—Oct. 3, 1901. No. 43582.

Hobbing Worm Wheels in a Lathe. Illustrates and describes an arrangement for this work. 600 w. Am Mach—Oct. 3, 1901. No. 43586.

Lathes.

Double Boring and Turning Mill. Illustrates and describes a vertical lathe suitable for turning pieces up to 14 in. diameter by 7 in. high. 500 w. Engr, Lond—Oct. 4, 1901. No. 43759 A.

Machine Tools.

Railway Machine Tools at the Paris Exposition, 1900 (Die Werkzeugmaschinen zur Herstellung und Reparatur von Eisenbetriebsmitteln auf der Pariser Weltausstellung 1900). H. Unger. A review of the machine tools exhibited at Paris, with especial reference to their use in railway repair shops. Serial, Part I. 2500 w. Glaser's Annalen—Sept. 15, 1901. No. 43937 D.

The Tooling of Machines. John Ashford. On the preparing of the tools and the getting of the machines into proper working condition. The present article gives an illustrated and detailed description of selected work. 3500 w. Engng—Oct. 11, 1901. Serial. 1st part. No. 43858 A.

Mechanical Plant.

The Boys' Industrial School at Lancaster, Ohio. Illustrates and describes the general features of a mechanical plant for a number of detached buildings. 2100 w. Eng Rec—Oct. 5, 1901. No. 43662.

The Mechanical Plant of the Cornell Medical College, New York. Illustrated description of a large ventilating, heating and cooling plant, also operating an extensive electric lighting system, a refrigerating plant, and an hydraulic elevator installation. Full details are given. 6000 w. Eng Rec—Oct. 5, 1901. No. 43660.

Pig Casting.

The Development of the Pig Casting Machine. A. E. Fay. Compares the different makes, showing who conceived the fundamental ideas of the modern machines, and who first put them into practical operation, tracing the development, and describing the latest improvements. 4700 w. Ir Age—Oct. 10, 1901. Serial. 1st part. No. 43682.

Portable Tool.

Universal Portable Machine Tool (Machine Outil Transportable Universelle). F. Morin. An illustrated account of the portable tool of Capitaine for drilling, boring, milling, etc. 1800 w. Génie Civil—Oct. 5, 1901. No. 43919 D.

Screws.

Cutting Square Threaded Screws. A. L. de Leeuw. Explains how it is possible to cut a square-threaded screw with anything but square threads, even though the greatest care and best tools be used. Ill. 2000 w. Am Mach—Oct. 17, 1901. No. 43811.

Shop Heating.

Ventilation and Heating in the Denver Shops of the Colorado Road. Illustrated description of a fan system of heating in which a comparatively small number of outlets from the ducts suffices for buildings of large volume. 1600 w. Eng Rec—Oct. 12, 1901. No. 43780.

Shops.

American Machine Shops from a German Viewpoint. Peter Lüders. Mr. Lüders' concluding paper reviews some of the popular fallacies concerning American methods and sets forth their true essentials. 4000 w. Engineering Magazine—November, 1901. No. 44053 B.

A Modern Machine Shop (Eine Moderne Maschinen fabrik). E. Alberts. A description of the new and well-arranged plant of the Aschersleben Machine Works, at Aschersleben, in Prussia. 2000 w. Stahl und Eisen—Sept. 1, 1901. No. 43949 D.

The Westinghouse Electric & Mfg. Co.'s Works. Illustrates and describes interesting things seen at the machine shops of this company. 3000 w. Mach, N. Y.—Oct, 1901. No. 43516.

The Works and Some of the Product of Alfred Herbert, Ltd., of Coventry, England. Illustrated detailed description of large tool-works. 900 w. Am Mach—Oct. 17, 1901. Serial. 1st part. No. 43810.

Steel Rails.

Some Suggestions as to Specifications for Steel Rails. E. F. Kenney. Gives suggestions concerning the composition, blooming, segregation, finishing, straightening and testing. Ill. 2700 w. Eng News—Oct. 3, 1901. No. 43664.

Stereotyping.

The Autoplate—An Automatic Stereotyping Machine. Illustrated detailed description of the machine and its operation. 1500 w. Sci Am Sup—Oct. 26, 1901. No. 43880.

Tools.

Tools for Automobile Tire Valves. Joseph V. Woodworth. An illustrated description of the punches, dies and tools used in making the valves for pneumatic tires. 800 w. Am Mach—Oct. 10, 1901. No. 43700.

Torpedo Works.

The Whitehead Torpedo Works at Fiume. Gives the history of the evolution of the Whitehead torpedo, with illustrated description of the propelling mechanism and other essentials, and of the works. 3500 w. Engng—Sept. 20, 1901. No. 43555 A.

Wrenches.

Making Bicycle Wrenches. Illustrates and describes the making and use of the tools for producing a medium-priced wrench. 1600 w. Am Mach—Oct. 3, 1901. No. 43583.

MATERIALS OF CONSTRUCTION.

Cast Iron.

Notes on the Chemical Constitution of Cast Iron and Steel. A. Carnot and E. Goutal. From *Annales des Mines.* An account of investigations dealing with the elements. 8000 w. Metallographist—Oct., 1901. No. 43849 F.

The Constitution of Cast-Iron, with Remarks on Current Opinions Concerning It. Discussion of Prof. Howe's paper. 2500 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44062.

The Temperature Limits for the Separation of Graphite from Martensite in Pure Cast Iron. Hugh P. Tiemann. Experimental work done in the Metallurgical Laboratory of Columbia University. 3900 w. Metallographist—Oct., 1901. No. 43850 F.

Flat Plates.

The Strength of Flat Plates. Albert E. Guy. Criticizes an article by George E. Barrett, and compares the formulas given in his article with those of Grashof. 1800 w. Am Mach—Oct. 10, 1901. Serial. 1st part. No. 43699.

Metallography.

The Process of Metallography in 1900. Albert Sauveur. A brief critical review of the year. 5000 w. Metallographist—Oct., 1901. No. 43848 F.

Taylor-White Steel.

High Speed Tool Steel (Schnelldrehstahl). A report of the Berlin section of the Verein Deutscher Ingenieure, upon the capabilities of special German steels for lathe tools; with numerous diagrams. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 28, 1901. No. 43904 D.

Testing.

The Drop Test Upon Nicked Bars (Essai des Métaux par Choc sur Barreaux Entaillés). A. Dutreux. A review of the paper of Mr. Charpy before the *Société des Ingénieurs Civils de France;* followed by comments by M. A. Pourcel. 2500 w. Génie Civil—Sept. 28, 1901. No. 43917 D.

The Optical Examination of Metallic

Surfaces (Examen Optique des Surfaces Métalliques). J. Vinsonneau. A discussion of the manner in which approaching rupture may be detected by a critical examination of surface changes in the parts of machines. 2000 w. Revue Technique—Sept. 25, 1901. No. 43927 D.

The Testing of Metals by the Bending of Nicked Bars (Essai des Métaux par Pliage de Barrettes Entaillées). Ch. Frémont. A further discussion of the method of drop tests upon nicked bars, showing that reliable results may be obtained from small test bars. 7500 w. Bull Soc d'Encour—Sept. 30, 1901. No. 43932 G.

POWER AND TRANSMISSION.

Air Compression.

The Hydraulic Compression of Air. William O. Weber. Briefly reviews the various devices used, especially describing the compressors on the Taylor principle. 1400 w. Power—Oct., 1901. No. 43679.

Cableways.

Cableways for Handling Iron Ore. Waldon Fawcett. Illustrates and describes some recent plants of interest. 1700 w. Am Mfr—Sept. 26, 1901. No. 43513.

Chain Driving.

Some Recent Developments in Chain Driving. C. R. Garrard. Read before the Glasgow Congress. States the requirements for chain driving or transmission, discussing the elements of durability, efficiency, etc. Ill. 3000 w. Auto Jour—Oct., 1901. No. 44038 A.

Conveyors.

Coal Shipping in India. Illustrated description of a coal conveyor designed by Sir Bradford Leslie, particularly with a view to the obtainment of the greatest value from the coolie labor. 2200 w. Ir & Coal Trds Rev—Oct. 18, 1901. No. 44031 A.

The Mechanical Handling of Coal, Ore and Pig Iron. Illustrates some new devices and new applications of old devices, giving descriptions. 5000 w. Ir & Coal Trds Rev—Oct. 11, 1901. No. 43870 A.

Drilling Machine.

The Fosdick and Holloway Drilling Machine. Illustrated detailed description. 1800 w. Ir Age—Oct. 24, 1901. No. 43871.

Gear Teeth.

Some Reasons for Increasing the Obliquity of Involute Teeth. Robert A. Bruce. Discusses the increased strength of teeth as the obliquity is augmented, showing that the efficiency and wearing qualities of the teeth are improved. 2200 w. Am Mach—Oct. 10, 1901. No. 43701.

Power Cost.

An Investigation of the Cost of Power. Clyde D. Gray. An investigation undertaken to get a collection of reliable data on the production, cost and utilization of power by different methods. 4800 w. Jour Fr Inst—Oct., 1901. Serial. 1st part. No. 43693 D.

Power Plants.

Test of an Industrial Power Plant. Gives the results of experiments on the power plant of engine-building works before and after improvement. Taken from paper of James Crighton and W. G. Riddell, presented at the Glasgow Congress. 900 w. Eng Rec—Oct. 12, 1901. No. 43777.

The Power Plant of the Colonial Hotel, Nassau, Bahama Islands. Illustrated description of a small station noteworthy for the garbage crematory connected with the boiler plant and for the system of steam piping. 2000 w. Eng Rec—Oct. 12, 1901. No. 43774.

SPECIAL MOTORS.

Binary Engine.

Combined Vapor Engines (Les Machines à Vapeurs Combinées). A description of the Josse form of binary engine in which the heat of the exhaust steam is used to vaporize sulphur dioxide for use in a second engine. 1200 w. Génie Civil—Sept. 14, 1901. No. 43911 D.

The Waste Heat Engine (Die Abwärne Kraftmaschinen). H. Baum. A description of the Josse and Zimmermann binary engines, using the heat in the exhaust of a steam engine to vaporize sulphur dioxide for use in a second motor. 2000 w. 5 plates. Glückauf—Sept. 7, 1901. No. 43962 B.

Gas Engines.

Second Report to the Gas-Engine Research Committee. Frederic W. Burstall. An account of the tests made, with tabulated results. Ill. 11500 w. Inst of Mech Engrs—Oct. 18, 1901. No. 44046 D.

Studies on Gas Motors (Untersuchungen am Gasmotor). E. Meyer. A full account of investigations made with varying degrees of compression and other working conditions, upon the engine in the mechanical laboratory at Göttingen. The calibration and comparison of indicators is especially discussed. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—Sept. 14, 21, 1901. No. 43900 each D.

STEAM ENGINEERING.

Boilers.

Modern Boiler Problems. E. D. Meier. Abstract of a paper presented to the N. Eng. Cotton Mfrs. Assn. on the modifications of boiler plants for special services. 2100 w. Eng Rec—Oct. 12, 1901. No. 43779.

On a Form of Double-Tube Boiler.

John Irving. Read before the Inst. of Naval Architects. Illustrates and describes the construction and performance of these boilers. 1900 w. Prac Engr—Sept. 27, 1901. No. 43650 A.

Steam Boiler and Elevator Defects. An illustrated review of the exhibit made by the Fidelity & Casualty Company of New York at the convention recently held by the Nat. Assn, of Stationary Engrs. in Rochester, of defects found by inspectors. 3600 w. Ins Engng—Oct., 1901. No. 43508 C.

Why Use Yarrow Boilers? (Warum Yarrow Ketels?). A. D. F. W. Lichtenbelt. A study of water tube boilers with especial reference to small straight-tube boilers of the Yarrow type. 3500 w. De Ingenieur—Aug. 24, 1901. No. 43994 D.

See also Mechanical Engineering, Automobiles.

Boiler Test.

Boiler Test at the Dalbusch Mine near Gelsenkirchen (Verdampfungs und Indikatorversuch ausgeführt auf Schacht I der Bergwerksgesellschaft Dalbusch zu Gelsenkirchen). Data and results of tests of engines and boilers of a mine hoisting plant. 1200 w. Glückauf—Oct. 5, 1901. No. 43966 B.

Comparative Practice.

English, American, and Continental Steam Engineering. Philip Dawson. The first of a series of papers treating of modern power-house practice. The present one is devoted to the characteristics of British engine types and practices. 3500 w. Engineering Magazine—November, 1901. No. 44049 B.

Cylinders.

Cylinders for Steam Engines. W. H. Wakeman. Explains plans for determining the diameters of steam engine cylinders for various conditions, presenting examples. 2300 w. Elec, N. Y.—Oct. 30, 1901. No. 44042.

Engine Construction.

Large Work by the Westinghouse Machine Company. Illustrates some of the recent work of this firm on large vertical Corliss engines, giving description. 1200 w. Am Mach—Oct. 3, 1901. No. 43581.

Engines.

Triple-Expansion Engines, South Shields. Illustrated description with report of tests of a surface-condensing, electric-lighting engine. 1800 w. Engr, Lond —Oct. 18, 1901. No. 44028 A.

Flow of Steam.

The Flow of Steam Through Orifices. A review of experiments undertaken by A. Rateau at St. Etienne. 500 w. Eng Rec—Oct. 26, 1901. No. 43888.

Oscillating Engine.

The Oscillating Engine of the Connecticut. Illustrates and describes the changes made in an engine of a Long Island Sound steamboat. 1400 w. Power—Oct., 1901. No. 43678.

Pistons.

The Strength of Pistons (Festigkeit von Scheibenkolben). G. Schwarz. A mathematical examination of the stresses and strains in steam-engine pistons, especially those of the solid disc form. 1000 w. Zeitschr d Ver Deutscher Ing—Oct. 5, 1901. No. 43905 D.

Power House.

The Modern Power House Including the Use of Cooling Towers for Condensing Purposes. J. H. Vail. Calls attention to improvements aiming at economy which may with advantage be introduced. 2500 w. St. Ry Rev—Oct. 12, 1901. No. 43804 C.

Separators.

Positive Steam and Oil Separating and Water Cooling Towers. Francis H. Boyer. Read at meeting of the New England Cotton Mfrs Assn. Illustrates and describes a method of reclaiming water from exhaust steam in almost absolute purity and removing the oil. 1500 w. Power —Oct., 1901. No. 43680.

Steam Plant.

The Steam Plant of the Fall Mountain Electric Light and Power Company. Illustrated description of a 500-H.-P. stand-by plant with vertical boilers using induced draft, and a special concrete coal bin, built to supplement a hydraulic plant. 800 w. Eng Rec—Oct. 19, 1901. No. 43836.

Steam Pump.

The Pulsometer Steam Pump. Joseph C. Riley. Describes the pulsometer and its operation and gives indicator diagrams, and report of tests. 3800 w. Tech Qr—Sept., 1901. No. 43691 E.

Turbines.

The Steam Turbine. Illustrative description of the De Laval steam turbine, with an account of the results attained and related matter of interest. 1500 w. Sci Am Sup—Oct. 26, 1901. No. 43882.

Valve Gears.

Caring for Corliss Valve Gears. W. H. Wakeman. Suggestions and discussion of some of the features. 1200 w. Engr, U. S. A.—Oct. 1, 1901. No. 43600.

MISCELLANY.

Address.

Presidential address to the Mechanical Science Section of the British Association at the Glasgow Meeting. R. E. Crompton. Considers recent developments in means of locomotion on land, especially the congested street traffic in cities and towns, and means of rapid transit. 6000 w. Engng—Sept. 20, 1901. No. 43580 A.

Presidential Address before the British Association for the Advancement of Science. Prof. A. W. Rucker. The address deals chiefly with the doubts recently cast on the soundness of the atomic theory, and the accepted theories of science. 11800 w. Engr, Lond—Sept. 13 and 20, 1901. Serial. 2 parts. No. 43579 each A.

Aeronautics.

Count de la Vaulx's Balloon Trip Across the Mediterranean. An account of experimental voyages, especially the most recent one, with illustrations of the balloon. 1300 w. Sci Am—Oct. 26, 1901. No. 43878.

The Cooling of Gas for Inflating Balloons. (Sur le Refroidissement Préalable des Gaz Employés au Gowflement des Ballons). Ch. Lambert. Showing that the removal of contained moisture and other impurities in the gas adds to the length of floating period. 1000 w. Revue Technique —Sept. 25, 1901. No. 43928 D.

The "Santos-Dumont No. 6." from *L'Illustration.* Illustrates and describes some features of the air-ships recently tried. 1100 w. Sci Am—Oct. 5, 1901. No. 43602.

Alcohol Fuel.

Paris Exhibition of Alcohol-Consuming Apparatus. Concerning an exhibition in Paris of inventions for the use of alcohol for illuminating or heating purposes, or for motor power. 1000 w. U S Cons Repts, No. 1161—Oct. 14, 1901. No. 43704 D.

Apprenticeship.

A Systematic Plan of Apprenticeship. Describes the plan at the Baldwin Locomotive Works, with editorial comment. 2000 w. Am Engr & R R Jour—Oct., 1901. No. 43594 C.

Artillery.

Notes on Rapid-Fire Field Artillery. The present article gives an account of the Belgian competitive trials for the choice of a rapid-fire field gun, examining the question from the point of view of the qualities required for good field material. Many illustrations. 3500 w. Jour U S Art—Sept.-Oct., 1901. Serial. 1st part. No. 43829 D.

The Development of the Modern Field Guns. Wilmot E. Ellis. Traces the development of the field gun from 1890-1891 to the present time. 5900 w. Jour U S Art—Sept.-Oct., 1901. No. 43828 D.

Our Improved Artillery (Notre Nouvelle Artillerie). Léo Dex. A discussion of the great advantages obtained by the use of field artillery in which the recoil is taken up in such a manner as to leave the aim undisturbed. 1500 w. Revue Technique —Sept. 25, 1901. No. 43925 D.

Calculating Machines.

The Construction of Algebraic Machines (Sur la Construction des Machines Algébriques). L. Torres. A discussion of the mechanical devices of the author for the summation of series, and for the permutation of roots. Serial, Part I. 5000 w. Revue de Mécanique—Sept. 30, 1901. No. 43930 E + F.

Coal Pockets.

Steel Coal Storage Pockets. H. G. Tyrrell. A brief illustrated description of a new form of construction now used in preference to the pockets built of heavy timber. 1200 w. R R Gaz—Oct. 4, 1901. No. 43666.

Cold Storage.

Cold Storage of Furs and Fabrics. Madison Cooper. Reviews the beginnings of this industry, discussing points connected with it. Also gives extract from an article by Dr. Albert M. Read. Ill. 3000 w. Ice & Refrig—Oct., 1901. No. 43598 C.

Drying Plant.

The Principles and Design of Modern Drying Plant. Shows the demand for artificial drying apparatus, and studies the relations between the vaporized water and the heat required, also other important points. 2600 w. Engr, Lond—Oct. 4, 1901. Serial. 1st part. No. 43758 A.

Exposition.

The Glasgow International Exposition (L'Exposition Internationale de Glasgow). Léon Guillet. A very fully illustrated account of the Glasgow exhibition from a French point of view. 3000 w. Génie Civil —Sept. 21, 1901. No. 43913 D.

Heating.

Distribution of Hot Water. Alton D. Adams. Discussion of the supply of heat by hot water; how to calculate for the degree of heat desired; differences in temperature, etc. 2000 w. Archts & Builds Mag—Oct., 1901. Serial. 1st part. No. 43668 C.

Hot Water Heating in a Chicago Residence. Illustrated description of an open gravity installation with direct and indirect radiation. 1600 w. Eng Rec—Oct. 19, 1901. No. 43840.

The High-Pressure System of Heating by Hot Water. Frederick Dye. An illustrated description of the system, with a statement of the advantages and disadvantages. 3800 w. Plumb & Dec—Oct. 1, 1901. No. 43807 A.

Volume of Water in Hot Water Heating Apparatus. W. M. Mackay. Read before the Am. Soc. of Heat & Ven. Engrs. Discusses the great difference of opinion, and states the volume that has given best results in the practice of the writer. 1500 w. Dom Engng—Oct. 15, 1901. No. 43833 C.

Heating and Ventilating.

Heating and Ventilating the Glasgow Art Galleries. An illustrated description of the plant. The arrangement is on the plenum system. 1500 w. Engr, Lond—Sept. 20, 1901. No. 43562 A.

Ventilation and Heating of Buildings. G. H. Bryce. Read at the convention of the Ontario Assn. of Archts. Considers the principles that must be understood to heat economically and efficiently. 3500 w. Met Work—Oct. 19, 1901. No. 43813.

Ventilation and Heating of the Houses of Parliament, England. A general description of the methods now employed for ventilating this structure. 1200 w. Eng Rec—Oct. 26, 1901. No. 43895.

Kinematics.

Binary Systems and Elementary Kinematic Couples (Les Systemes Binaires et les Couples d'Eléments Cinématiques). G. Koenigs. An examination of complete closure, partial closure, and force closure in connection with simple kinematic systems. 1000 w. Comptes Rendus—Sept. 23, 1901. No. 43935 D.

Laboratory.

The Engineering Laboratory of the Technical High School at Stuttgart (Das Ingenieur Laboratorium der Kgl. Technischen Hochschule Stuttgart). C. Bach. With views of the exterior and interior of the building, and plans and sections of the rooms. 3000 w. 2 plates. *Zeitschr d Ver Deutscher Ing—Sept. 21, 1901. No. 43902 D.

Safety.

Factors of Safety. Robert Henry Smith. Presidential address, Civil and Mech. Engrs. Soc. Discusses in detail the conditions affecting the factor of safety, the systematic testing of materials, etc. 5000 w. Engr, Lond—Oct. 11, 1901. No. 43869 A.

Telescopes.

Large Astronomical Telescopes (Ueber Grosse Astronomische Fernrohre). Paul Hoppe. A historical review dealing with the mechanical side of the subject, and giving especial attention to the great telescope of the Treptow observatory. Two articles, 5000 w. 2 plates. Glaser's Annalen—Sept. 15, Oct. 1, 1901. No. 43938 each D.

Thermodynamics.

Energy from Terrestial Heat. Jacob T. Wainwright. Discusses inaccuracies in "second law" of thermodynamics, and the means of converting heat of matter into available energy. 3300 w. Ice & Refrig—Oct., 1901. No. 43599 C.

Weighing Machine.

The Blake-Denison Continuous Weighing Machine. An illustrated detailed description. 1100 w. Engng—Oct. 4, 1901. No. 43763 A.

MINING AND METALLURGY

COAL AND COKE.

Bituminous Coal.

The Development of the Bituminous Coal Industry. William Gilbert Irwin. Reviews the history of this industry. 1800 w. Sci Am—Oct. 19, 1901. No. 43822.

Coal Mine.

The New Plant of the Scharnhorst Mine at Brackel near Dortmund (Die Neue Schacht Anlage "Scharnhorst" in Brackel bei Dortmund). F. Schulte. Describing power plant, lighting, coal washing, pumping, etc., of a modern mining installation. 3500 w. 10 plates. Glückauf—Sept. 7, 1901. No. 43961 B.

The Rhine-Elbe Mine of the Gelsenkirchen Mining Company (Die Schachtanlage Rhein-Elbe III. der Gelsenkirchener Bergwerks A-G.). With map and plans of the hoisting machinery, power plant, and general installation. 3000 w. 4 plates. Glückauf—Sept. 7, 1901. No. 43960 B.

Coal Supplies.

Some Practical and Economic Problems in Relation to Our Coal Supplies. J. Stephen Jeans. From the *Proceedings* of the South Wales Inst. of Engrs. Considers the coal reserves, cost of working, waste, coal-cutting machinery, etc. 5500 w. Ir & Coal Trds Rev—Sept. 20, 1901. No. 43563 A.

New Zealand.

New Zealand Coal Mines. Abstracts in reference to the workings at the principal mines and districts visited by the Royal Commission, taken from the report to Parliament. 11600 w. N Z Mines Rec—Aug. 16, 1901. No. 43553 B.

Progress.

Colliery Engineering Progress. C. M. Percy. Reviews the early history of tunneling machines and of the application of compressed air power for running them. 3600 w. Mines & Min—Oct., 1901. No. 43616 C.

Russia.

Russian Coal. Editorial discussing the coals fields of Russia and their development, and the temporary remission of duty on coal imported into certain parts of the country. 1800 w. Engng—Oct. 18, 1901. No. 44024 A.

Scotland.

Some notes on the Output of Coal from the Scottish Coal field. R. W. Dron. Read before the British Assn. Considers the economic circumstances affecting the output, and concludes that if wisely handled the coalfields of Great Britain will supply many generations. 2700 w. Ir & Coal Trds Rev—Sept. 27, 1901. No. 43646 A.

Some Notes on the Scottish Coalfields. Observations during a recent visit, describing the character of these coal seams. 2500 w. Ir & Coal Trds Rev—Oct. 4, 1901. No. 43756 A.

Screening.

The Screening of Anthracite. Diagram and description illustrating the system employed in the breakers of the D., L. & W. R. R. Co., and considered typical of the best practice. 1300 w. Col Guard—Sept. 20, 1901. No. 43566 A.

Transvaal.

An interesting Coal Deposit in the Transvaal. An account of the Syferfontein deposit and its discovery. 1300 w. Col Guard—Oct. 11, 1901. No. 43864 A.

Virginia.

Southwest Virginia Coal Belt. Joseph Virgin. An illustrated description of the coal and coke plant of the Virginia Iron, Coal & Coke Co. 1000 w. Mines & Min—Oct., 1901. No. 43618 C.

The History and Conditions of Mining in the Richmond Coal-Basin, Virginia. J. B. Woodworth. Also brief discussion. 2500 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44065 D.

COPPER.

Losses.

Losses in Copper Smelting. Ronald C. Campbell-Johnston. Discusses the methods employed at Swansea, in Wales, and the modifications that have to be adopted in new countries. 1200 w. B C Min Rec—Oct., 1901. No. 43794 B.

New Process.

Improved Method of Manufacturing Copper, Yellow Metal, and Naval Brass. H. J. Martin. Describes a process consisting of the utilization of the heat, resulting from the refining operation, for the purpose of carrying out the rolling in the "breaking-down" and "drawing-on" stages, thus doing away entirely with any re-heating. 1600 w. Ir & Coal Trds Rev—Sept. 20, 1901. No. 43565 A.

Precipitation.

Copper Precipitation. Detailed account of the processes used in the artificial or mechanical precipitation of copper. 1800 w. Min & Met—Oct. 1, 1901. No. 43621 C.

GOLD AND SILVER.

Assaying.

A Rapid Assay for Silver and Gold in Metallic Copper. George L. Heath. Describes the method, giving results and related information. 2300 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44061 D.

Brazil.

The Morro Velho Gold Mine, Brazil. Illustrated detailed description of this great gold mine, opened upon the ruins of an old mine which had been worked many years. 6000 w. Eng & Min Jour—Oct. 19, 1901. No. 43844.

Bryan Mill.

The Bryan Mill as a Crusher and Amalgamator. Continued discussion of the paper of E. A. H. Tays. 400 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44071.

California.

Mining in Lower California. J. D. Lowry. An account of the development, the various enterprises, the minerals found, the topography, characteristics, ownership, laws, &c. 4300 w. Eng & Min Jour—Oct. 12, 1901. No. 43785.

Carolina.

Notes on the Carolina Gold Deposits. Walter Harvey Weed. Concerning the character and treatment of the ore, cyaniding experiments, &c. 1300 w. Eng & Min Jour—Oct. 19, 1901. No. 43846.

Colorado.

The Mining Development of Gilpin County, Colorado. Thomas Tonge. With especial reference to the gold producing districts, showing the evolution of mining methods, and the reduction of costs. 4000 w. Engineering Magazine—Nov., 1901. No. 44052 B.

East Kootenay.

The So-Called "Sand Carbonates" at the Paradise Mine, Windmere District. Charles F. Nicholson. Describes the development work. The "Sand Carbonates" carry about 50 per cent. lead and 60 per cent. silver. Ill. 1100 w. B C Min Rec—Oct., 1901. No. 43793 B.,

Gold.

The Commercial Importance of Gold Mining to Germany (Der Goldbergbau und Seine Wirtschaftliche Bedeutung für Deutschland). B. Knochenhauer. A comparison between the commercial importance of gold, iron and coal mining, showing the necessity of obtaining command of gold mining districts. 2500 w. Glückauf—Oct. 12, 1901. No. 43967 B.

Goldfield.

Phillips River Goldfield. H. P. Woodward. Extracts from a report by the consulting government geologist of Western Australia, relating to this district. 1400 w. Aust Min Stand—Aug. 29, 1901. Serial. 1st part. No. 43675 B.

Hydraulic Mining.

Note on Hydraulic Mining in Low-Grade Gravel. William H. Radford. A report of actual figures in working property in Northern California. 700 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 44070.

Milling.

Milling Practice at Idaho Springs, Colo. H. Foster Bain. Describes the treatment of pyritic ores and lead ores. Generally the values in the pyritic ores are in gold, and the lead ores in silver. 2000 w. Eng & Min Jour—Oct. 5, 1901. No. 43628.

New Mexico.

The Mogollon Range. Illustrated description of the region near Cooney, New Mexico; the ores yield gold and silver about equally; the production and processes of treatment are discussed. 5300 w. Mines & Min—Oct., 1901, No. 43615 C.

New Zealand.

The Coromandel Goldfields, (N. Z.). J. Malcolm MacLaren. Read before the Inst. of Min. Engrs, (London). The present article describes their geological character. 1200 w. Aust Min Stand—Aug. 22, 1901. Serial. 1st part. No. 43608 B.

Nuggets.

Crystalline Structure of Nuggets. A. Liversidge. Extracts from an address describing some recently obtained nuggets from Victoria and the Klondike and New Zealand. Ill. 1000 w. Aust Min Stand—Sept. 12, 1901. No. 43853 B.

Placers.

Placer Mining in Southern Oregon. Dennis M. Stavel. An account of the mining industry in this region and the working of the placers. Ill. 1600 w. Min Rept—Sept. 26, 1901. No. 43528.

Silver.

The Delamar and the Horn-Silver Mines: Two Types of Ore-Deposits in the Deserts of Nevada and Utah. S. F. Emmons. Illustrated description of deposits in an arid climate presenting interesting structural peculiarities. 7000 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44569 D.

Transvaal.

Gold-Mining in the Transvaal, South Africa. John Hays Hammond. Describes in detail the Witwatersrand district and its operation, and discusses the mining plants and methods, milling, treatment, &c. Ill. 13700 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44057 D.

IRON AND STEEL.

America.

American Iron Works and their Appliances (Amerikanische Eisenhütten und deren Hülfsmittel). Ernest Langheinrich. A descriptive review of the American iron industry, including transport and handling of ore, and the general auxiliary appliances to the manufacture. Serial. Part I. 3000 w. Stahl und Eisen—Sept. 15, 1901. No. 43950 D.

Basic Steel.

Basic or Open-Hearth Steel (Thomas oder Martin Flusseisen). F. Grassman. A discussion of the comparative commercial advantages of the basic and acid open-hearth processes for the manufacture of low steel. 1500 w. Stahl und Eisen—Oct. 1, 1901. No. 43953 D.

Blast Furnaces.

Blast Furnaces of American Design at Mariupolsk (Hochofen Amerikanischer Construction auf dem Hüttenwerk zu Mariupolsk). A. Brezgunow. A full account of the extensive iron works on the Sea of Azov, Russia, where the plant is closely modeled after that at Duquesne, Pennsylvania. Two articles. 5000 w. Stahl und Eisen—Sept. 1, 15, 1901. No. 43948 each D.

Cast Steel.

Jupiter Steel. An illustrated description of the manufacture of an exceptionally high grade of cast-steel which is made from wrought-steel scrap, with a mixture of other metals. The patents of Andres G. Lundin. 1100 w. Sci Am—Oct. 12, 1901. No. 43736.

Development.

The Development of the American Iron and Steel Industries. Extracts from a report issued by James M. Swank. 2000 w. Col Guard—Oct. 11, 1901. No. 43866 A.

Electrical Burner.

The Electrical Burner for Blast-Furnaces. F. L. Grammer. Describes the device and its success in burning open tuyeres and cinder holes which have become "frozen." 700 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 44063 D.

Furnace Gases.

The Composition of Blast Furnace Gases (Berechnung der Zusammensetzung der Hochofengase). Bernhard Osann. An examination of the chemical composition and thermal value of blast furnace gases, and their relations to the blast and fuel. 3000 w. Stahl and Eisen —Sept. 1, 1901. No. 43947 D.

Iron Ores.

Geological History of the Hematite Iron Ores of the Antwerp and Fowler Belt in New York. W. O. Crosby. Ill. 2500 w. Tech Qr—Sept., 1901. No. 43-689 E.

Luxemburg.

Hydrographic and Geological Notes

upon the Ore Deposits in Southern Luxemburg (Hydrologisch-Geologischer Beitrag zum Minette Vorkommen in Süd-Luxemburg). K. Limpach. With sections of strata and a colored geological map showing iron ore deposits. 3000 w. 1 plate. Stahl und Eisen—Sept. 15, 1901. No. 43951 D.

Monessen System.

The Monessen System. From an article in *Tin and Terne,* describing the Donner process of rolling black plate. 2500 w. Ir Age—Oct. 10, 1901. No. 43681.

Rod Mill.

Efficiency Test of a Continuous Rod Mill. Describes the plant and method of testing used at a two weeks' test of the plant of the Morgan Construction Co. of Worcester, Mass. Ill. 1200 w. Ir & Coal Trds Rev—Sept. 27, 1901. No. 43647 A.

Slag.

The Composition of Blast Furnace Slag (Zur Constitution der Hochofenschlacke). L. Blum. With analyses of various slags, and a discussion of the conditions of their formation. 2000 w. Stahl und Eisen—Oct. 1, 1901. No. 43954 D.

Steel Works.

The Works and Operations of Messrs. Bolckow, Vaughan & Co., Limited. Illustrated description of the blast furnaces, converting plant, open-hearth steel plant, rail and plate mills, &c. 2500 w. Ir & Coal Trds Rev—Sept. 20, 1901. Serial. 1st part. No. 43564 A.

Strength.

The Effect of Time and Temperature on the Strength of Steel and Iron. Ernest George Coker. Extracts from a paper read before the Canadian Soc. of Civ. Engrs. An account of experimental investigations made in the Testing Laboratory of McGill Univ. 1600 w. Can Engr—Oct., 1901. No. 43576.

MINING.

Accidents.

Accidents in Coal Mines of Pennsylvania. Facts from the report of the Chief of the Bureau of Mines for the year 1900. 4000 w. Mines & Min—Oct., 1901. No. 43619 C.

Air Currents.

Analogies of Electric Currents and Mine Air Currents. Some of the analogies that have been observed are noted, and another article will discuss the important differences. 2000 w. Col Guard—Sept. 27, 1901. Serial. 1st part. No. 43645 A.

Arizona.

Notes on the Geology of Southeastern Arizona. E. T. Dumble. Description based on recent investigations. 8000 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44058 D.

Explosives.

Explosives in Coal Mines. The new order issued by the Home Secretary adding to the special list of permitted explosives and amending previous orders. 2600 w. Col Guard—Sept. 27, 1901. No. 43644 A.

Nitro-Glycerine Explosives. Remarks on the increased use of these explosives in mining and the safest way of handling and employing them. 1900 w. Aust Min Stand—Aug. 22, 1901. No. 43609 B.

Fire Damp.

Fire-Damp Explosives in the Dortmund District (Die Schlagwetter Explosionen im Oberbergamtsbezirk Dortmund). A review of the explosives during 1900, compared with the barometrical readings, showing the relation between the flow of gas and the atmospheric pressure. 1200 w. 1 plate. Glückauf—Sept. 21, 1901. No. 43963 B.

Fire Protection.

Mine Appliances at the Berlin Fire Protection Exposition (Der Bergbau auf der International Ausstellung für Feuerschulz in Berlin). R. Danilof. With illustrations of nozzles and connections especially adapted for mine service. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 28, 1901. No. 43958 B.

Ignition.

The Prevention of Defective Firing with Electrical Igniters (Die Beseitigung der Versager bei der Elektrischen Schusszündung). G. A. Meyer. A full review of the methods of electrical ignition of blasting charges in mining, with an examination of the causes of defective ignition. 5000 w. Glückauf—Sept. 28, 1901. No. 43964 B.

Mexico.

Hidalgo del Parral, Chihuahua, Mexico. Illustration and brief description of this town, attracting attention because of the recent mining developments. 1500 w. Eng & Min Jour—Oct. 12, 1901. No. 43784.

Notes on the Mining and Metallurgical Industries of Mexico. Joseph Struthers. Discusses the geology, mineral resources, production, &c., giving illustrated descriptions of important districts. 12800 w. Eng & Min Jour—Oct. 26, 1901. No. 43896.

Prospecting in the Mexican Mineral Country. Theodore S. DeLay. An entertaining account of the life of a prospector in Mexico, with much useful and practical information. 5000 w. Engineering Magazine—Nov., 1901. No. 44056 B.

Mining Machinery.

The Purchase of Mining Machinery.

Frederick T. Snyder. Discusses the technical and commercial aspects. 2500 w. Min & Sci Pr—Oct. 5, 1901. No. 43702.

Mining Plant.

See Electrical Engineering, Power Applications.

Mining Schools.

The Obligations of Mining Schools to the Industry. James Park. Discusses the knowledge of importance that should be required. 3200 w. N Z Mines Rec—Aug. 16, 1901. No. 43554 B.

Newfoundland.

The History of Mining in Newfoundland. James P. Hawley. A review showing the slow but steady growth. Ill. 7500 w. Can Min Rev—Sept. 30, 1901. No. 43529 B.

Quarrying.

On the Use of the Wire Saw for Quarrying Slate. G. J. Williams. Reprinted from Dr. C. Le Neve Foster's report. Illustrated general description of the wire-saw, and its operation. 3300 w. Quarry—Oct. 1, 1901. Serial. 1st part. No. 43703 A.

Sampling.

Notes on Sampling. Suggestions of importance to secure correct sampling, with discussion of methods. Ill. 2500 w. Min Rept—Oct. 24, 1901. No. 44019.

Shafts.

New Automatic Shaft-Closing Device. A. Padour and V. Sperling. From *Oesterreichische Zeitschrift für Berg und Hüttenwesen.* An illustrated description of the device and its operation. 600 w. Col Guard—Oct. 4, 1901. No. 43761 A.

Shaft-Sinking.

Methods and Cost of Shaft Sinking in the Ruhr District (Leistungen und Kosten beim Schachtabteufen im Ruhrbezirk). L. Hoffmann. Giving tabulated data concerning effectiveness and cost of deepening and lining shafts by various methods; including the Kind-Chaudron system. 4000 w. 1 plate. Glückauf—Sept. 7, 1901. No. 43959 B.

Recent Developments in Shaft Sinking. Paper read by Oberingenieur Riemer at the meeting of the German Min. Assn. at Dortmund. An illustrated account of recent improvements in old methods, and the introduction of new processes. 2200 w. Col Guard—Oct. 4, 1901. Serial. 1st part. No. 43760 A.

Spain.

The Mining Industries of Spain. H. L. Geissel. An illustrated description of works recently visited by the writer, with information obtained. 2500 w. Min & Met—Oct. 1, 1901. No. 43620 C.

Surveying Instruments.

The Evolution of Mine-Surveying Instruments. Dunbar D. Scott. Concluding discussion of paper on this subject. Ill. 3800 w. Trans Am Inst of Min Engrs—Oct., 1901. No. 44059 D.

Timbering.

Some Methods of Timbering and Working Wide Lodes in New South Wales. J. R. Godfrey. An illustrated study of a few typical cases of actual mining where the local conditions modify the methods employed. 1600 w. Min Rept—Oct. 3, 1901. Serial. 1st part. No. 43674.

Ventilation.

The Closing of a Hoisting and Ventilating Shaft at Neumühl near Oberhausen (Der Abschluss des zur Förderung Dienenden Wetterschachtes auf Zeche Neumühl bei Oberhausen). A description of the method by which the outlet of a shaft was closely connected to a ventilating flue and yet retained available for hoisting. 1500 w. Glückauf—Oct. 5, 1901. No. 43965 B.

MISCELLANY.

Alloys.

The Alloys of Antimony andTellurium. Henry Fay and Harrison Everett Ashley. An account of investigations made, describing the methods and apparatus used. Ill. 3300 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 44068 D.

New Researches on the Alloys of Gold, Silver, and Other Matter Found in the Egyptian Tombs. M. Berthelot. Results of examinations made. 1000 w. Sci Am Sup—Oct. 26, 1901. No. 43881.

Aluminium.

The Commercial Importance of Aluminium. Ernest Wilson. Read before the British Assn. Deals with the progress in manufacture, alloys, uses, &c. 3500 w. Engng—Sept. 27, 1901. No. 43638 A.

Carnotite.

The Commercial Preparation of Vanadium and Uranium Compounds from Carnotite. Dr. J. Ohly. Describes the treatment by a continuous process, eliminating the vanadium contents, and recovering the uranium remaining in the residue. 2300 w. Min & Met—Oct. 1, 1901. No. 43622.

Cobalt.

Note on the Occurrence of Cobaltiferous Quartz in the State of Jalises, Mexico. Frederic Chisholm. Brief description of the deposit. 500 w. Eng & Min Jour—Oct. 26, 1901. No. 43897.

Concentrating Machinery.

The Klein Jig and the Klein Classifier. Ferdinand H. Regel. Illustrated description of a jig and an ore-classifier of new design used with galena and other lead ores. 800 w. Trans Am Inst of Min Engrs. Nov., 1901. No. 44064 D.

New South Wales.

The Mineral Resources of New South Wales. T. A. Rickard. Review of information given in a recently issued volume by the government geologist, Edward F. Pittman. 3000 w. Eng & Min Jour—Oct. 19, 1901. No. 43845.

Petroleum.

Prospecting for Oil in Colorado. Prof. Arthur Lakes. An illustrated description of the oil springs, the Archuleta oil field, the San Juan River anticline and the Navajo basin. 3400 w. Mines & Min—Oct., 1901. No. 43617 C.

Prospects of the Texas Oil Field. C. F. Z. Caracristi. Considers the actual financial condition of the oil business in Texas, and discusses the scientific side. Ill. and map. 8300 w. Mfrs Rec—Oct. 3, 1901. No. 43578.

The Increased Consumption of Petroleum in California. W. G. Young. Statements concerning the consumption and production of petroleum in this state. 900 w. Eng & Min Jour—Oct. 5, 1901. No. 43629.

Potassium Salts.

The Potassium Salts Industry of Germany. E. Mackay-Heriot. Considers the mining laws, types of occurrences, &c. 2400 w. Eng & Min Jour—Oct. 12, 1901. No. 43786.

Sulphides.

Sulphide Ore Treatment. An account of experimental work carried out by E. A. Ashcroft and James Swinburne. Gives an illustrated description of the modified Phœnix process. 1700 w. Aust Min Stand—Aug. 29, 1901. No. 43677 B.

Tin.

Complex Tin Sulphides. An explanation of methods for their successful metallurgical treatment. 2600 w. Aust Min Stand—Aug. 29. 1901. No. 43676 B.

Tin Mining in Tasmania. Describes the alluvial deposits at Mount Bischoff. 1800 w. Aust Min Stand—Aug. 15, 1901. No. 43607 B.

Wolframite.

Some Recently Exploited Deposits of Wolframite in the Black Hills of South Dakota. J. D. Irving. A study of the geology, occurrence and character of the ore, with report of analysis made. 4000 w. Trans Am Inst of Min Engrs—Feb., 1901. No. 44067 D.

Zinc.

Zinc Production for 1900. Charles Kirchoff. A review of the year. 2200 w. Am Mfr—Oct. 17, 1901. No. 43847.

Zinc and Lead.

Diverse Origins and Diverse Times of Formation of the Lead and Zinc. Deposits of the Mississippi Valley. Charles R. Keyes. A study of these deposits believing them to have a diverse genesis, and discussing the geological date of the formation. 3000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 44060 D.

The Zinc and Lead Deposits of North Arkansas. John C. Branner. Describes the general geology, the ore deposits in their various forms, and the relation of the geologic structure to the ore-bodies, the composition and quality of the ores, &c. Ill. 6000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 44066 D.

RAILWAYS AND TRAMWAYS.

CONDUCTING TRANSPORTATION.

Accidents.

The Claim Department. D. W. Patterson. Read before the N. Y. State Ry. Assn. Discusses claims honest and dishonest, the precautions to be taken against accidents, and the need of intelligent employees. 4400 w. St Ry Jour—Sept. 28, 1901. No. 43725 D.

Train Accidents in the United States in August. Record of accidents with notes. 3800 w. R R Gaz—Oct. 18, 1901. No. 43821.

Double-Heading.

Double-Heading with Heavy Engines. Report of a committee of the Central Railway Club, with discussion. 3000 w. R R Gaz—Oct. 25, 1901. No. 44018.

Railroad Operations.

An Analysis of Railroad Operations. S. M. Hudson. Criticises the classification of earnings and operating expenses adopted by the Interstate Commerce Commission and by railroads generally and outlines a classification giving more definite results. 2000 w. Ry Age—Oct. 4, 1901. No. 43631.

Tonnage Rating.

Suggestions for the Establishment of a Practical System of Tonnage Rating. B. A. Worthington. Outlines the system that has been worked out on the Pacific system lines of the So. Pacific Co., giving results for the past year. 1600 w. Am Engr & R R Jour—Oct., 1901. No. 43593 C.

FINANCIAL.

Accounts.

Capital Accounts from the Viewpoint of Investors and the Public. Col. T. S. Williams. Read before the N. Y. State Ry. Assn. Briefly considers some recent catastrophes in railroad finances due to improper swelling of capital accounts, with general discussion of the subject. 3400 w. St Ry Jour—Oct. 12, 1901. No. 43731 D.

Purchasing and Storeroom Accounting on the Brooklyn Rapid Transit System. A review of the blanks and methods used for properly purchasing, checking, recording and distributing material and supplies. 2200 w. St Ry Rev—Oct. 15, 1901. No. 44007 C.

Report of Committee on Standard Blanks and Accounting for Material and Supplies. F. E. Smith. Presented at convention of N. Y. State St. Ry. Assn. 4000 w. St Ry Jour—Oct. 12, 1901. No. 43732 D.

English Railways.

Tabular Statement of the Expenditure in the Locomotive, Carriage, and Wagon Departments of English Railways. Shows the cost of working and receipts of the eleven principal railways of England. 900 w. Engr, Lond—Oct. 18, 1901. No. 44030 A.

Interurban.

An Interurban Railway as an Investment. Guy Morrison Walker. Discusses the earnings of electric lines as compared with steam roads, the passenger traffic, and the carrying of freight and express. 3000 w. St Ry Rev—Sept. 15, 1901. No. 43537 C.

MOTIVE POWER AND EQUIPMENT.

Apparatus.

Electric Railway Apparatus. Ernst J. Berg. Discusses the characteristics of the various apparatus, and to a certain extent, their limitations. The discussion of storage batteries is omitted. 7000 w. Trans Am Inst of Elec Engrs—Aug.-Sept., 1901. No. 43800 D.

Boosters.

The Use of Series Boosters in Connection with Street Railways. W. J. Davis, Jr. Read before the N. Y. State St. Ry. Assn. Explains the service where the series booster is of special value, explains its requirements, and the limitations of its economical use. 1400 w. St Ry Jour—Sept. 21, 1901. No. 43722 D.

Brakes.

Brakes for Electric Street Surface Cars. Charles R. Barnes. Read before N. Y. State St. Ry. Assn. Reviews the changed conditions in street car operation, and the need of an efficient brake. Comments on some of the recent improvements, and suggests what is needed in a perfect brake. 2500 w. St Ry Jour—Sept. 14, 1901. No. 43719 D.

Brakes in Railroad and Street Car Service. F. M. Nellis. The paper is largely a narration of actual occurrences seen by the writer while serving as traveling inspector and instructor for the Westinghouse Air Brake Co. Also general discussion. 30000 w. N Y R R Club—Sept. 26, 1901. No. 43827.

Edward Hills' Improved Either-Side Brake. An illustrated description of a brake claiming to combine cheapness and efficiency. 2000 w. Col Guard—Oct. 11, 1901. No. 43865 A.

The Siemens Electro-Pneumatic Brake (Le Frein Electro-Pneumatic Siemens). A description of the Siemens electric apparatus for use in connection with air brakes to enable a more prompt setting to be obtained. 2500 w. Revue Technique —Sept. 25, 1901. No. 43926 D.

Brake Rigging.

A Brake Rigging for Double Truck Cars. Myron Rounds. Gives diagram of brake levers, and points out the essential features and reasons for them in a design that has given satisfaction. 1000 w. St Ry Rev—Sept. 15, 1901. No. 43540 C.

Birkenhead, Eng.

Birkenhead Corporation Electric Tramways. Briefly reviews the history of tramways, illustrating and describing their recent electrical equipment. 2500 w. Tram & Ry Wld—Sept. 12, 1901. No. 43543 B.

Brooklyn.

Some Railway Problems of Brooklyn. J. L. Greatsinger. An illustrated article explaining some of the reasons why the service is at present inadequate and the plans being adopted to increase the efficiency. 2000 w. St Ry Jour—Oct. 5, 1901. No. 43713 D.

The Power Stations and Distributing System of the Brooklyn Rapid Transit Company. C. E. Roehl. An illustrated account of the proposed power development, outlining the present equipment. 3500 w. St Ry Jour—Oct. 5, 1901. No. 43716 D.

Bronx.

The Trolley in the Bronx Region. Edward A. Maher. Explains the character of this district, giving illustrations. Its parks draw the pleasure-seekers, and it is rapidly becoming a residential section, through the influence of its trolley lines. 4000 w. St Ry Jour—Oct. 5, 1901. No. 43717 D.

Car Heating.

Notes on Railway Carriage Heating. Notes containing observations of a trip from the North of England to Central

Italy at Christmas time, noting the sensations of comfort or discomfort over eight lines of railways, the systems of heating, &c. 2000 w. Engr, Lond—Sept. 27, 1901. No. 43643 A.

Car Maintenance.

Car Maintenance on the Metropolitan Street Railway, New York. Thomas Millen. An illustrated article concerning the types and equipment of the cars and their maintenance. 2800 w. St Ry Jour—Oct. 5, 1901. No. 43710 D.

Cars.

New Dining Car on the Denver & Rio Grande Ry. Illustrates and describes a car of fine construction and unique features. 600 w. Ry Mas Mech—Oct., 1901. No. 43572.

100,000 Lbs. Capacity Steel Flat Car—Chicago & Alton Ry. Illustrated detailed description. 500 w. R R Gaz—Oct. 25, 1901. No. 44017.

The Best Form of Car for City Service. Eugene Chamberlin. Read before the N. Y. State Ry. Assn. An illustrated article discussing the most satisfactory vehicle for electric roads in regard to efficiency, economy, convenience and comfort. 2500 w. St Ry Jour—Oct. 12, 1901. No. 43726 D.

The Brill New Semi-Convertible Car. An illustrated description of a new type of semi-convertible car. 2000 w. Ry Mas Mech—Oct., 1901. No. 43573.

Wagons of High Capacity for British Railways. Illustrates and describes two types of cars of new design. 1700 w. Engng—Oct. 18, 1901. No. 44022 A.

Chart.

The Tractive Power Chart. Lawford H. Fry. Gives a chart designed as a time and labor-saving device for use in the calculation of the cylinder tractive power of a locomotive. 1800 w. Am Engr & R R Jour—Oct., 1901. No. 43597 C.

Comparison.

A Three-Year Comparison of Cable, Electric and Horse Traction in New York City. Table showing in detail the earnings and operating expenses for the year ending June 30, 1901, of the Metropolitan St. Ry. Co. of New York, and comparing with the cable and horse traction formerly used. 1500 w. St Ry Jour—Oct. 5, 1901. No. 43718 D.

Conduits.

Electric Conduits. Reviews three articles published in the June number of *Traction and Transmission.* 2000 w. Elec Rev, Lond—Oct. 4, 1901. No. 43754 A.

Couplers.

The Car Coupler Problem. J. E. Thomas. Outlines a design of the writer, stating its advantages. 4500 w. St Louis Ry Club—Sept. 13, 1901. No. 43509.

Croydon.

Croydon Corporation Electric Tramways. An illustrated description of the system, and account of the undertaking of this English borough. 1100 w. Elect'n, Lond—Oct. 4, 1901. No. 43752 A.

Distribution System.

The Electrical Distribution System of the Metropolitan Street Railway Company, New York. Walter A. Pearson. Illustrates and describes the largest polyphase alternating-current distribution for railway purposes yet put in operation. It is notable for the large amount of energy distributed per square mile of territory served. 3500 w. St Ry Jour—Oct. 5, 1901. No. 43709 D.

Draft Appliances.

Locomotive Draft Appliances. The first of a series of articles upon tests made by Prof. Goss of Purdue Univ., to bring the information on this subject up to date and render it applicable to the large locomotives of the present. This number is mainly a discussion of existing information. 2200 w. Am Engr & R R Jour—Oct., 1901. Serial. 1st part. No. 43591 C.

Electric Equipment.

The Electrification of the Metropolitan Railways. An editorial statement of the situation and discussion of the Ganz system. 3300 w. Engng—Oct. 11, 1901. No. 43860 A.

Electric Signals.

The Adoption of Electric Signals on Suburban and Interurban Railways, of Single or Double Track and Their Economy of Operation. William Pestell. Read before the Am. St. Ry. Assn. Discusses the experience of steam roads, the use of the telephone, the systems generally used, types of electric signals, &c. 2200 w. St Ry Rev—Oct. 12, 1901. No. 43802 C.

Havana.

Urban Transportation in Havana. G. F. Greenwood. Illustrated description and particulars relating to the electric railway. 1400 w. St Ry Rev—Oct. 15, 1901. No. 44006 C.

Headlights.

Acetylene Gas Generator for Locomotive Lighting. Illustrated description of a new apparatus in trial on the Chicago & Northwestern. 700 w. R R Gaz—Oct. 11, 1901. No. 43790.

Acetylene Headlights on Locomotives. From a paper by George Landis Wilson, presented at the convention of the Traveling Engrs. Assn., giving considerable information about the use of acetylene for headlights. 1500 w. Ry Age—Oct. 11, 1901. No. 43767.

Locomotives.

American Locomotives for New Zealand. Illustrations and general dimensions of three locomotives furnished for the Government Railways of New Zealand. 1100 w. Ry & Engng Rev—Sept. 28, 1901. No. 43515.

Compound Locomotives in South America. R. Gould. Read before the Glasgow Congress. Some particulars of the results of the compound locomotive on the Buenos Aires Great Southern Railway, Ill. 1700 w. Engng—Sept. 27, 1901. No. 43637 A.

Double Bogie Suburban Locomotive (Machine de Grande Banlieue, à Deux Bogies). G. Du Bousquet. Illustrated description of locomotives designed for the mixed suburban traffic of the Northern Railway of France about Paris. 2500 w. 3 plates. Rev Gen de Chemins de Fer—Oct., 1901. No. 43955 H.

Four-Cylinder Compound Express Locomotive (Locomotive Compound à Grand Vitesse, à Quatre Cylindres). F. Barbier. Description of the engine exhibited at Paris by the Hanover Machine Works, at Linden, near Hanover. 2000 w. 1 plate. Génie Civil—Sept. 28, 1901. No. 43916 D.

Russian Locomotives at the Exposition of 1900 (Les Locomotives Russes à l'Exposition de 1900). R. Godfernaux. Illustrated description of the engines exhibited by the works of Poutiloff, Kolomna, and Briansk. 4000 w. 10 plates. Rev Gen de Chemins de Fer—Aug., 1901. No. 43957 H.

Steam Locomotive for a Speed of 200 Kilometres per Hour (Dampflokomotiven für 200 km St. Geschwindigkeit). R. Sanzin. A discussion of the essentials of a locomotive to make a speed of 125 miles per hour. 2000 w. Glasers Annalen—Oct. 1, 1901. No. 43939 D.

Ten-Wheel Compound Locomotives, Union Pacific Railroad. Brief illustrated description of heavy engines for passenger service. 250 w. Ry & Engng Rev—Oct. 5, 1901. No. 43672.

The Latest North-Eastern Six-Coupled Express Engines. Charles Rous-Marten. Particulars of the actual work performed by these engines. 2700 w. Engr, Lond—Oct. 4, 1901. No. 43757 A.

The Vauclain Compound Locomotive. C. T. Noyse. Read at meeting of the Pacific Coast Ry. Club. Briefly considers the present standing of various types of compound locomotives, and gives information regarding the construction and operation of the Vauclain type. 3000 w. Ry Mas Mech—Oct., 1901. No. 43574.

Vauclain Consolidation Compound Atlantic Type Passenger Locomotive—Chicago, Milwaukee and St. Paul Ry. Illustrated detailed description. 800 w. Am Engr & R R Jour—Oct., 1901. No. 43595 C.

London Tramways.

Electric Tramways of the London United Tramways. The first of a series of articles giving an illustrated detailed description of the conversion and extension of the tramway system, and the introduction of electricity. 1700 w. Elect'n, Lond—Oct. 18, 1901. Serial. 1st part. No. 44035 A.

Manhattan Co.

Manhattan Railway Co., of New York. Brief account of this system which comprises the elevated roads on Manhattan Island, and the Suburban Railroad north of the Harlem River. 1800 w. St Ry Rev—Sept. 15, 1901. No. 43533 C.

Metropolitan Power Plants.

Notes on the Metropolitan Street Railway Power Plants. M. G. Starrett. Gives the results of the operation of the Ninety-sixth street power house, the largest electric railway power house in the world. Ill. 4200 w. St Ry Jour—Oct. 5, 1901. No. 43708 D.

Metropolitan Ry.

The Upbuilding of the Metropolitan Organization. H. H. Vreeland. Briefly reviews the history of the organization and its development, especially the human factor. 3000 w. St Ry Jour—Oct. 5, 1901. No. 43706 D.

The Metropolitan Street Railway System. Discusses the development of the company through consolidations, the history of cable traction and the underground electric conduit, some of the operating conditions, &c. Ill. 4000 w. St Ry Rev—Sept. 15, 1901. No. 43531 C.

Modern Practice.

Notes on Modern Electric Railway Practice. Albert H. Armstrong. A review of some of the more important problems in electric traction now in course of installation or under serious discussion. 4500 w. Trans Am Inst of Elec Engrs—Aug., Sept., 1901. No. 43799 D.

Railway Motor.

The Railway Motor of the Company "La Francaise Electrique" (Les Moteurs de Tramways de la Société "La Française Electrique"). Ilustrating and describing an improved form of enclosed motor for tramway service. 1500 w. Revue Technique—Sept. 25, 1901. No. 43923 D.

Return Current.

The Best Method of Conducting the Return Current to the Power House. E. G. Connette. Read before the Am. St. Ry. Assn. Discusses rail-binding. the trouble experienced, &c., and advocates the use of a jointless and independent metallic return, connected to each rail. 1300 w. St Ry Rev—Oct. 12, 1901. No. 43803 C.

Rolling Stock.

Rolling Stock Construction in Italy. Illustrates and describes recent examples of the rolling-stock made at the works of the Officine Meccaniche of Milan. 2700 w. Engng—Oct. 11, 1901. No. 43859 A.

The Rolling Stock of Greater New York. Eugene Chamberlin. An illustrated description of the cars at present operated. 3500 w. St Ry Jour—Oct. 5, 1901. No. 43715 D.

Safety Appliances.

Safety Appliances for Electric Tramways (Sicherheitsvorschriften für Elektrische Bahnanlagen). The adopted report of the committee of the German Electrotechnical Association, providing standards for tramway stations and plants. 2500 w. Elektrotech Zeitschr—Sept. 19, 1901. No. 43971 B.

Sand Dryer.

Improved Sand Dryer and Bin for Locomotive Sand. Drawings and description of a new rotary sand dryer recently put into service on the Chicago, Milwaukee and St. Paul Ry. 400 w. Am Engr & R R Jour—Oct., 1901. No. 43596 C.

Southend-on-Sea.

Southend-on-Sea Electric Tramways. Illustrated detailed description of a recently opened electric tramway. 1400 w. Tram & Ry Wld—Sept. 12 1901. No. 43544 B.

Steam Plants.

Comparative Review of the Steam Plants of Three Large Electric Traction Main Stations in New York City. William Kent. The article criticises the lines that have been followed and suggests means by which considerable economy would have been effected. Ill. 11600 w. St Ry Jour —Oct. 5 1901. No. 43712 D.

Storage Batteries.

The Application of Storage Batteries to the System of the Brooklyn Heights Railroad Company. Franklin E. Morse. Read before the N. Y. State St. Ry. Assn. Describes the storage-battery equipment explaining why it was installed and giving causes and particulars of its successful operation. 2800 w. St Ry Jour—Sept. 21, 1901. No. 43721 D.

Suburban Development.

The Development of Suburban Territory. J. C. Brackenridge. Shows the effect of the trolley roads on the property through which they pass, and the tendency to seek suburban homes when they are accessible. Ill. 2500 w. St Ry Jour—Oct. 5, 1901. No. 43714 D.

Subway.

The New York Rapid Transit Subway. Briefly reviews the steps leading to the work now under construction, and gives an illustrated account of the undertaking. 4200 w. St Ry Jour—Oct. 5, 1901. No. 43711 D.

Third-Rail.

Third-Rail Interurban Railways. Maurice Hoopes. Read at the Rochester meeting of the New York State St. Ry. Assn. States the reasons why third-rail construction is preferable to the trolley where its use is possible, compares cost, notes its disadvantages, and commends the system for a large class of roads. 3700 w. St Ry Rev—Sept. 15, 1901. No. 43542 C.

Tires.

Comparative Study of the Breakages of Tires and of Solid Wheels (Statistique Comparée des Ruptures et Avaries de Bandages et de Roues Pleines). E. Biard. An exhaustive study based on the reports of the German Railway Union from 1887 to 1896. 15,000 w. Rev Gen de Chemins de Fer—Oct., 1901. No. 43956 H.

Tramway Practice.

Recent Tramway Practice. Notes suggested by Mr. James More's paper, read before the Glasgow Congress. 2500 w. Elec Rev, Lond—Oct. 18, 1901. No. 44-033 A.

Transmission.

Alternating and Direct-Current Transmission on City Lines. M. S. Hopkins. Read before the N. Y. State St. Ry. Assn. Explains the main features of polyphase alternating transmission with rotary converter sub-stations working in connection with existing direct-current feeder system. 3600 w. St Ry Jour—Oct. 12, 1901. No. 43730 D.

Trolley.

Schnectady-Albany Trolley Line. Illustrates and describes the latest improvements in electric railway engineering as shown in this lien over an old turnpike used as a toll-road over a hundred years ago. 1700 w. St Ry Jour—Sept. 28, 1901. No. 43724 D.

Valves.

Note on Balanced Valves (Note sur les Tiroirs Equilibrés). A communication from the Eastern Railway of France upon the behavior of the balanced slide valves used upon the "Series 3000" locomotives of that road. 3000 w. Revue de Mécanique—Sept. 30, 1901. No. 43931 E+F.

NEW PROJECTS.

Construction.

Current Railway Construction. A review of the construction operations in which the principal railway companies of the United Kingdom are at present engaged. 1500 w. Engng—Oct. 11, 1901. No. 43862 A.

High Speed.

The Electrical High-Speed Experiments at Berlin. Describes the means by which the high-speed problem is to be tested in

Germany, and the preparations for the experiments. Ill. 1000 w. U S Cons Repts, No. 1154—Oct. 5, 1901. No. 43577 D.

The High Speed Electric Motor Car of the General Electric Company (Der Elektrisch Schnellbahnwagen der Allgemeinen Elektricitats-Gesellschaft). O. Lasche. A German version of the author's paper presented at the Glasgow Engineering Congress. 3000 w. Elektrotech Zeitschr—Sept. 26, 1901. No. 43973 B.

The Siemens and Halske High-Speed Motor Car (Der Schnellbahnwagen von Siemens & Halske A. G. Berlin). W. Reichel. A very full description of the electric motor cars designed for the Marienfeld-Zossen line, with details as to wind resistance, motive power, etc. 7500 w. 1 plate. Three articles. Zeitschr d Ver Deutscher Ing—Sept. 28, Oct. 5, 12, 1901. No. 43903 each D.

Transandine.

Buenos Ayres and Valparaiso Transandine Railway. Arthur H. Sleigh. An account of an important road in South America, the progress of the work, the portion completed, and related matter of interest. Ill. 2000 w. R R Gaz—Oct. 11, 1901. No. 43789.

PERMANENT WAY AND FIXTURES.

Curves.

Transition Curves. C. A. Sundstrom's discussion of a paper by W. B. Lee. 1500 w. Pro Am Soc of Civ Engrs—Oct., 1901. No. 44004 E.

Transition Curves. George D. Snyder. Discussion of a paper on this subject by W. B. Lee. 900 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43506 E.

Derailers.

The Derail: Its Past, Present and Possible Future. E. D. Wileman. Discusses the faults of derails in general use, and the perfect derail, its requirements, &c. Ill. 1700 w. R R Gaz—Oct. 11, 1901. No. 43788.

Joints.

Are the Best Results Obtained From the Use of Broken or Square Joints? L. Bradley and F. J. Allen. From a report of a committee presented before the Roadmasters' and Maintenance of Way Assn. 1200 w. Ry & Engng Rev—Oct. 12, 1901. No. 43797.

Oiling.

Oiled Roadbeds. Waldon Fawcett. Describes the operation of oiling a roadbed, illustrating the oil-sprinkling train. Also an account of its successful use on highways. 1100 w. Sci Am—Oct. 26, 1901. No. 43877.

Old Tramway.

The Old Stratford and Moreton Railway. Describes. Gives a descriptive account of a tramroad opened for traffic in 1826. It was designed originally for the taking up of coals, lime, &c., from the canal and river navigation at Stratford for a prosperous agricultural district, and bringing down its produce. 1500 w. Engr, Lond—Sept. 20, 1901. No. 43561 A.

Rapid Transit.

System of the Brooklyn Rapid Transit Co. An illustrated article dealing with some of the operating conditions, traffic across Brooklyn Bridge, consolidations, excursion traffic, &c. 8000 w. St Ry Rev—Sept. 15, 1901. No. 43534 C.

The Rapid Transit Situation in Boston. Louis Bell. Critical comments on the present situation and the outlook for future improvements. 2400 w. Elec Rev, N Y.—Sept. 28, 1901. No. 43517.

The Rapid Transit Tunnel and Railway. A brief illustrated review of the work actually accomplished and a description of the tunnel so far as the plans have been perfected. 3000 w. St Ry Rev—Sept. 15, 1901. No. 43532 C.

Roundhouses.

An Up-to-Date Roundhouse. Illustrated description of a new plant at Collinwood, on the Lake Shore & Mich So. Ry. 700 w. Am Engr & R R Jour—Oct., 1901. No. 43592 C.

Signals.

Automatic Block Signaling on the Boston Elevated. Illustrated description of details taken from a bulletin issued by the Union Switch & Signal Co. 5000 w. R R Gaz—Oct. 11, 1901. No. 43787.

Electric Interlocking for the C., R. I. & P. and the B. & O., at South Englewood, Chicago. Illustrated description of important installations in Chicago. 1500 w. Ry & Engng Rev—Sept. 28, 1901. No. 43514.

English and American Railway Signalling. J. Pigg. Reviews the methods of protection that have been in use at various times, and discusses present practice. Ill. 1700 w. Elec Rev, Lond—Sept. 27, 1901. Serial. 1st part. No. 43652 A.

Maintenance of Automatic Electric Block Signals. H. S. Balliet. From a paper presented at Buffalo meeting of the Ry. Sig. Club. Considers the maintenance of track circuits, signal circuits and the maintenance force. 1700 w. Ry & Engng Rev—Oct. 5, 1901. No. 43671.

The Krizik Block Signal System (Das Block Signal System Krizik). A. Prasch. A description of the improved block system of Krizik, in which the semaphores and switches are operated direct by electric power. Two articles, 6000 w. Zeitschr d Oesterr. Ing u Arch Ver—Sept. 27, Oct. 4, 1901. No. 43940 each B.

Stations.

The New Pennsylvania Station at

Pittsburg. Illustrated description of a fine structure nearing completion. It combines an office building with commodious arrangements for the traveling public. 1600 w. Ry Age—Oct. 4, 1901. No. 43632.

The New York Central Station, Albany, N. Y. Plan, photographic views and description of a fine structure. 600 w. Archts & Builds Mag—Oct., 1901. No. 43669 C.

Track Construction.

Permanent Way for Electric Tramways. W. Howard Smith. Extracts from a paper read before the Incorporated Assn. of Munic. & Co. Engrs. (England). Considers rails, foundations, paving, &c. 5000 w. St Ry Rev—Oct. 15, 1901. No. 44008 C.

Steel Tie, Concrete Construction. Le Grand Brown. Read before the N. Y. State Ry. Assn. Describes the method adopted in the city of Rochester, N. Y., and gives the cost. Ill. 900 w. St Ry Jour—Sept. 21, 1901. No. 43723 D.

Rails and Track Construction on the Island of Manhattan. W. Boardman Reed. Reviews the various rails used, their advantages and disadvantages, describing the construction, giving cost in New York, &c. Ill. 3800 w. St Ry Rev—Sept. 15, 1901. No. 43541 C.

Track Construction in Brooklyn. E. H. Packe. Illustrated description of the rail section designed by J. C. Brackenridge. 1400 w. St Ry Rev—Sept. 15, 1901. No. 43536 C.

Track Construction on the Brooklyn Rapid Transit System. R. L. Russell. Describes the traffic conditions and the construction. 3400 w. St Ry Rev—Sept. 15, 1901. No. 43535 C.

Tracks.

Track Bonding. Alfred Green. Read before the N. Y. State St. Ry. Assn. Does not think the joints of the rail can be so bonded as to be a perfect success. Discusses the difficulties and the remedy. 1400 w. St Ry Jour—Sept. 14, 1901. No. 43720 D.

Tunnel Alterations.

Proposed Alterations in the Park Ave. Tunnel, New York City. An outline of the proposed changes, with a cross-section of the proposed construction. 700 w. Eng News—Oct. 17, 1901. No. 43817.

Turn-Tables.

Best Method of Operating Turn-Tables by Power. Report of committee to the Assn. of Ry. Supts. of Bridges and Bldgs. Gives tabulated information of turn-tables operated by electricity, gasoline engines, and steam, advising electricity where available. 1800 w. Ry & Engng Rev—Oct. 26, 1901. No. 44043.

Uganda Ry.

The Meridional Rift on the Uganda Railway. Illustrations and description of the temporary inclines on the Kikuyu escarpment of this railway. 700 w. Engng—Sept. 27, 1901. No. 43636 A.

Water Supply.

The Burlington's Water Supply at Galesburg. Illustrated description of a plant to cost $90,000, to supply the locomotives, shops and roundhouses of the C. B. & Q. R. R. 1600 w. Ry Age—Oct. 11, 1901. No. 43766.

TRAFFIC.

Car Mileage.

Car Mileage and How to Arrive at It Easily. J. M. Smith. Read before the N. Y. State Ry. Assn. Describes the forms bearing on this subject used by the Toronto Ry. Co. 1700 w. St Ry Jour—Oct. 12, 1901. No. 43733 D.

Coal Storage.

Coal Storage and Transfer Plant for the Chicago & Erie R. R. at Hammond, Ind. An illustrated description of a plant having a storage capacity of 60,000 tons, and facilities for handling coal in like proportion. 1400 w. Ry & Engng Rev—Oct. 12, 1901. No. 43796.

Differentials.

Railroad Discrimination Against New York, and the Remedy. Herman Conrow. Continued discussion of paper on this subject by Abel F. Blackmar. 5500 w. Pro Am Soc of Civ Engrs—Sept., 1901. No. 43502 E.

Manhattan.

Traffic and Traffic Conditions on Manhattan Island. Historical review of the street railways in New York city, the increase in traffic and growth of the transportation systems from the time of the first stage line. Ill. 4000 w. St Ry Rev—Sept. 15, 1901. No. 43530 C.

Mileage.

Train and Locomotive Mileage Statistics. E. F. Knibloe. Presented at St. Louis meeting of the Am. St. Ry. Assn. Reviews the manner the subject came before the association and the investigations undertaken and methods. 2200 w. Ry Age—Oct. 25, 1901. No. 44009.

New York City.

Traffic Conditions of New York City. Frank R. Ford. A review of the urban transportation problem, explaining the important characteristics and features of special interest, giving tables and diagrams comprising data of the system. Ill. 10700 w. St Ry Jour—Oct. 5, 1901. No. 43705 D.

Oil-Burning.

Oil-Burning Systems for Locomotives. Illustrates and describes the system patented by W. N. Best and W. A. Cooper. 500 w. Eng News—Oct. 24, 1901. No. 44013.

Railway Economics.

See Industrial Economics.

Traffic Curves.

Traffic Curves on the New Orleans and Carrollton R. R. A. H. Ford. Discusses how to prepare the traffic curve intelligently so as to show graphically the number of passengers carried throughout the car day, the number of cars provided to carry them, and the adequacy of the accommodation. 1500 w. St Ry Rev—Sept. 15, 1901. No. 43539 C.

MISCELLANY.

Address.

Address of Senator Chauncey M. Depew on Railroad Day at the Pan-American Exposition. Extracts relating to the number of men employed, the amounts paid in wages, for expenses, and for dividends, the change in rates, extent of service, and matters of interest. 2500 w. Ry & Engng Rev—Oct. 5, 1901. No. 43673.

Arbitration.

Arbitration Cases Decided in the High and Appeal Courts of the United Kingdom in Relation to Tramways and Tramcars. J. Neville Porter. Reviews important decisions, stating briefly the facts and the judgments concerning them, and the more significant reasons upon which the decisions are based. 2500 w. Tram & Ry Wld—Sept. 12, 1901. No. 43546 B.

Asia.

Russo-American Railways in Asia. Alexander Hume Ford. A review of the situation, the roads constructed and proposed, machinery needed, &c. 3200 w. Ir Age—Oct. 31, 1901. No. 44084.

Economies.

Goods and Mineral Traffic. Discusses affairs in England, the difficulties in making up heavy trains, and the need of improvements to secure economical handling. 2500 w. Engr, Lond—Oct. 25, 1901. No. 44133 A.

Fire Risks.

Fire Risks of Railways. W. S. Worman. Discusses the causes of fires and the remedies. Also general discussion. 7200 w. W Ry Club—Sept., 1901. No. 43695 C.

Interurban.

The Relation of Interurban Roads to City Roads. Ira A. McCormack. Read before the N. Y. State St. Ry. Assn. Discusses traffic agreements, rails, cars, and various matters, giving the agreement of various cities in the United States. 6600 w. St Ry Jour—Oct. 12, 1901. No. 43729D.

Locomotive Engineering.

Some Modern Tendencies of Locomotive Engineering. Charles Rous-Marten. The first of a series of articles discussing modern tendencies, and the lessons learned by experience. 2800 w. Engr, Lond—Sept. 20, 1901. Serial. 1st part. No. 43560 A.

London.

Mr. Yerkes on the London Situation. A letter to the London *Times*. Relates to the electrification of the Metropolitan Dist. Ry. 1500 w. St. Ry Rev—Sept. 15, 1901. No. 43538 C.

London Tramways.

The Tramways of the London County Council. A resume of the facts relating to the London tramway situation. 2500 w. Tram & Ry Wld—Sept. 12, 1901. No. 43545 B.

Officers.

Some of the Duties of Mechanical Officers. S. P. Bush. An interesting paper discussing these duties and illustrating by actual occurrences the position taken by the writer. General discussion. 10,000 w. W Ry Club—Sept., 1901. No. 43694 C.

Operation.

The Public, the Operator, and the Company. C. S. Sergeant. Read before the N. Y. State St. Ry. Assn. Considers some points in the relations of street railways to the public. 2800 w. St Ry Jour —Oct. 12, 1901. No. 43727 D.

Recent Practice.

Recent Tramway Practice. James More, Jr. Read before the Glasgow Congress. A review of present practice and its results, with remarks on different methods. Ill. 1500 w. Tram & Ry Wld —Sept. 12, 1901. No. 43547 B.

Street Railways.

Street Railways—A Review of the Past and a Forecast of the Future. Robert McCulloch. Read before the N. Y. State St. Ry. Assn. 4700 w. St Ry Jour—Oct. 12, 1901. No. 43728 D.

Train Resistance.

Train Resistance Formulas. John G. Crawford. A discussion of the subject with special reference to the resistance of the portion of the train behind the tender. 1800 w. Eng News—Oct. 31, 1901. No. 44109.

Transfers.

Transfers and Transfer Problems with Special Relation to New York. Oren Root, Jr. The writer considers the extensive transfer system is an important factor in the increased dividend earning power of the road. Describes the conditions in New York and the methods adopted. 3800 w. St Ry Jour—Oct. 5, 1901. No. 43707 D.

EXPLANATORY NOTE.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.

Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Ingenería. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Científico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

VOL. XXII. JANUARY, 1902. NO. 4.

INTERNATIONAL ASPECTS OF THE ISTHMIAN CANAL.

The construction of the best Isthmian canal is of so grave importance to Britain, France, and Germany, as well as the United States, that we ask most earnest attention to General Abbot's significant paper and the prefixed editorial introduction.

General Abbot, after retirement from the Corps of Engineers, U. S. A., spent three years as a member of the International Commission in minute study of the Isthmian canal question, bringing to it the pre-eminent ability which had already ranked him as one of the leading hydraulic engineers of the world. His work on the Mississippi is a classic.—THE EDITORS.

An Editorial Introduction to an Article by Gen. H. L. Abbot.

THE spectacle of a great nation committing a great folly may well cause the gravest distress. When, furthermore, that great nation, having received the confidence, the hearty accordance of a free hand in a free field, and the cordial Godspeed of the greatest of civilised powers, to the end that it may act for the best interests of material progress the world over, yet purposes to prostitute its opportunities at the spur of a narrow impatience—when, in short, the United States, absolved of treaty limitations, given sole powers and charged with sole responsibilities in the matter of the Isthmian Canal, appears ready to commit itself to so dubious, possibly impracticable, and certainly inefficient a project as the Nicaragua scheme—then it is time, not for despair, but for every effort to awaken reason and strengthen judgment before the fatal choice is made irrevocable.

The extraordinary thing is that this incredible folly is proposed in the face of facts which it has taken years of time and millions of money to obtain. According to the report of the "Walker Commission" the Nicaragua Canal would be 135 miles longer than the Panama, would have a greater summit elevation, more locks, and more and more difficult curvature; it would require 33 hours' time of transit for deep-draught vessels against 12 hours by the Panama route; it has no natural harbours at either end, while the Panama line has an excellent roadstead at the Pacific side and a serviceable harbour already in use on the Atlantic; the knowledge of the country and hence of possible contingencies in building is much less complete; the diffuseness of the work would make the difficulty of securing sufficient labour greater; there is no construction plant on the ground, and no means of transportation paralleling the line, while very perfect equipment in both regards exists at Panama; the cost of construction would be $45,000,000 more than the cost of completing the Panama undertaking, and the completed canal would cost $1,350,000 per annum more to maintain.

And yet, because of the terms offered by the Panama Canal Company, the commission is of the opinion that the most practicable and feasible location is that known as the Nicaragua route. In other words, they consider the price said to have been named by the French interests—about $100,000,000—unreasonable. It is fair to state, however, that the Panama representative denies that any figure was fixed.

Taking the figures as given, the net cost of the Panama Canal, finished, would be approximately $60,000,000 more than the estimate for the Nicaragua route. But the Nicaraguan estimate has been increased by each new commission. Even this last, in the light of all experience, will be enormously exceeded in construction. The Panama figures are based on actual knowledge gained in building nearly half the work, uncertainties being practically eliminated. And this is not the whole case. The saving of $1,350,000 a year in maintenance and operation would equal, on a 3 per cent. basis, a capitalisation of $45,000,000. This alone would nearly wipe out the alleged excess of construction cost. Further, Mr. George S. Morison, in a memorandum of dissent, urges that in certain particulars a wholly unnecessary expense of construction was charged against Panama, amounting to $10,000,000. Further, (and very reasonably,) that the estimation of engineering expense at the same percentage in both cases is manifestly unfair to the thoroughly explored Panama line, and that on this account $12,000,000 more should be added to the Nicaragua estimate. If this be so, the total would favour Panama by some $7,000,000, even paying the alleged price of the concession.

THE ENGINEERING MAGAZINE has no particle of concern with the rival interests except that of urging the measure which will in the end best serve the work of the world. It stands, as it has consistently stood from the outset, an outspoken advocate of the Panama Canal because the facts prove it will be the most serviceable to commerce, the most economical in operation, the greatest in potential traffic capacity, and the most adaptable to the rapidly increasing demands of navigation. In other words, it is the best tool for the intended use. The same policy which leads the Magazine steadily to urge the scrapping of inefficient machinery—on the principle that economy and capacity in operation outweigh immeasurably expense of installation—leads it also to stand squarely for the completion of the Panama route and the utter rejection of the Nicaraguan. For the United States, the very embodiment of restless activity in seeking the best appliances—of daring in casting out everything which is below the maximum of serviceability—to choose now deliberately the poorer instrument in this colossal investment, would be a reversal of national policy from which would grow a harvest of mortification and loss for years to come.

Concerning the propriety of the price said to have been asked by the French company we have no opinion, nor any concern with mere financial negotiations. It may be their business has been very badly handled. But the business of the United States will be much worse handled if they allow a mistaken enthusiasm, a false sentiment, a blind or prejudiced partisanship, or bad judgment to plunge them headlong into the morasses of the Nicaraguan project. Obviously it is to the interest of the New Panama Company to sell, and of the United States to buy. There must be a better way out of the muddle than that which the commission recommends.

We waited the report of the present commission with the admission (March, 1900,) that it was "conceivable that the merits of the Nicaraguan route would be so commanding as to make it advisable to abandon the work done on the other line and begin anew." The report, on the contrary, shows that at every conceivable point the Nicaraguan route is inferior. The United States will fall lamentably from every ideal in their history, political or industrial, of they seize the inferior and let the better go. If they are so misguided, others, wiser, will take what America rejects and, having the best, will leave her vanquished and dishonoured. Her perversity will be Britain's or Germany's opportunity.—THE EDITORS.

PRESENT CONDITION OF THE PANAMA CANAL.

By Gen. Henry L. Abbot.

THE history of the Panama Canal is marked by three distinct epochs. Inaugurated at the International Congress of 1879, with estimates based on no sufficient local investigations, and with contracts preceding the surveys of its engineers, the original "Compagnie Universelle du Canal Interocéanique," although supported at first by the reflected glories of the recent success at Suez, was compelled at the end of 1888 to abandon its undertaking from want of funds. The epoch of liquidation followed, marked by good sense and administrative ability of a high order. The receivers called to their assistance a commission of the ablest engineers of France to advise as to the technical features and the merits of the undertaking when conducted on business principles. The conclusion was reached that, while under existing conditions the construction of a sea-level canal was out of the question, a canal with locks was entirely practicable and might be made to meet all the requirements of a vast traffic; but that before beginning work on a grand scale, detailed examinations and investigations ought to be made to determine the best possible project for such a canal. To carry out this plan, the "Compagnie Nouvelle du Canal de Panama" was finally organized in October, 1894, with a capital of sixty-five million francs, and since that date has been at work with two objects in view:—(1) To investigate every element of the problem in the most thorough manner, in order to construct the best possible canal; and (2), so to locate the excavations as to avoid useless expenditures, whatever plan might ultimately be adopted. This paper is designed to set forth briefly the results attained.

Nature had placed on the Isthmus of Panama far less obstructions to the construction of a ship canal than on any other possible route between the oceans. Here only three formidable difficulties were to be apprehended; the cut at the continental divide, regulation of the Chagres river, and the tropical climate. Each will be considered in turn.

The deep cut at the Culebra has now quite lost the ancient terrors which hung over it in the closing days of the old company. The cutting at that date was in disintegrated materials near the surface, and serious caving and sliding had occurred, partly from natural causes and partly from neglect to secure proper drainage. The old company had made numerous borings, and they have been multiplied by the new company, with deep pits permitting the material to be inspected to the full depth adopted for the bottom of the canal; six million cubic yards have actually been removed since the resumption of the work, so placed as to secure depth rather than width and thus to throw light on future conditions; and lastly a tunnel 2,100 feet long and 20 feet by 13 feet in cross section has been driven at a low level without difficulty, at the point where the worst sliding had occurred. All the evidence thus secured concurs in establishing the fact that the dangerous material has already been passed, and that future deep cutting will lie chiefly in an indurated argillaceous schist which stands well even on steep slopes and in which caving is not to be feared. It may be added that the remaining heavy excavation is exaggerated in popular estimation, and the fact is often ignored that a very large volume has already been taken out. For example, the height of the continental divide on this route is constantly stated at its original figure, which on the line of the axis of the canal was really 345 feet above tide. The bottom of the cut there has now attained a level of 148 feet; and this, rather than the historic height, should be used in comparing the Panama with the other routes. Moreover, the length of the deep cutting, including the Emperador and Culebra sections, extends over about only five miles, and the really formidable cut over less than a mile. In fine, the old phantom of a sliding mountain and an impassable continental divide has been definitely laid at rest by the operations of the new company.

The problem of the regulation of the Chagres river demanded investigations of the most elaborate character. It is a stream having a basin above Bohio of about 700 square miles in surface. From this point the canal and river follow different routes to the sea, and at Gamboa, 13 miles above, they again separate. One problem, therefore, was to provide for the joint occupancy of 13 miles of valley without allowing interference with the canal in times of river floods; another was to determine with certainty whether the river could be made to supply sufficient water for canal purposes under the demands of any probable prospective traffic.

The records of the old company and of the liquidation period had contributed much valuable data as to the hydrography of the river during those years; but the new company inaugurated a series of observations without precedent on any tropical river. They included continuous registration of water level by tide gauges, frequent measurement of the discharge at all stages, daily rain records, and a collation of all known facts bearing on previous floods. Borings were multiplied at all sites favorable for the construction of dams and locks. Accurate level lines were run for scores of miles through the tangled forests to determine with precision the contours of projected reservoir lakes. In a word, nothing was omitted to permit the application of engineering science to every possible solution of the two hydraulic problems. Observations of this character have been in progress during the seven years since the new company undertook the work. Even today it continues to determine accurately the volume carried by the river at bi-hourly intervals at the three governing stations, and thus amply verifies the conclusions, which may be briefly stated as follows:

The Chagres river is characterized by two distinct regimens, one corresponding to the season of heavy rains, from May to December both included, and the other to the dry season covering three of the four remaining months of the year. During the former, the average discharge is about 3,900 cubic feet per second at Gamboa and 5,400 at Bohio, but it is subject to frequent freshets in which the volume may rise to 25,000 or even to 30,000 cubic feet, lasting however only for an hour or two. During the past quarter of a century, and so far as can be determined by the records of the Panama Railroad during the past half of a century, only five great floods have occurred. In by far the largest of them, that of November, 1879, the river carried a maximum volume liberally estimated at 112,000 cubic feet per second at Bohio, and at 73,000 cubic feet at Gamboa, but only during a period of two or three hours. The plans of the company for regulating the floods are based on the figures of this year, which are known to be far in excess of any other. During the dry season the Chagres is a quiet, peaceable stream with at Gamboa an average discharge of about 1,100 cubic feet per second, and in years of greatest drought a minimum average of 550 cubic feet. At Bohio the latter is about 750 cubic feet. The company has been careful to make its flood estimates err, if at all, in excess, and its low-water estimates err, if at all, by under-valuation. The provisions for river regulation contemplate two great artificial lakes—one formed by a dam at Bohio, creating a lake having 20 square miles of surface, and which for 13 miles will form the bed of the canal; the other above, on the upper river, for storage of water for lockages, etc. Together they will allow any excessive flood water to be held back, to be discharged gradually and thus rendered harmless to navigation. Such a system is superior to one immense natural lake, because, on the American Isthmus, the rainfall varies not only from year to year but also by periods covering several years. These variations cause corresponding variations of lake level, which are extremely difficult to regulate where the surface is large. Only one criticism has been raised against the reservoir plans adopted by the company. It has been asserted by those ignorant of its investigations that there will possibly be danger of leakage in the artificial lakes to be created. This matter was not overlooked by the engineers. Not only were the geological reports favorable, but the matter was put beyond question by a careful study of the monthly ratio between downfall and drainage in the basin above Bohio. Four years of records, all in perfect accord, have demonstrated that during the eight months of rains the soil becomes saturated with water, which in the dry season filters out into the river and constitutes a great part of the discharge at this season. As its source is much above the level established for the lakes, no leakage can escape from them because the soil is already super-charged. To explain in detail the calculations on which these several conclusions rest would far exceed the limits of this article, but they leave no doubt as to the correctness of the conclusions. The floods can be easily and perfectly controlled. So far as the low-water volume is concerned, an annual traffic of twenty-three million tons (more than double that of the Suez canal) can be certainly accommodated, with an ample water supply for lockages, electric lighting, and operating power. In a word, the investigations of the new company have proved that so far from being an obstacle to the canal, the Chagres river, regulated on the familiar system of locks and dams, is admirably suited to meet all the needs of navigation. No better source of supply could be desired.

It remains to consider the climate. Throughout the entire region where an Isthmian canal could be constructed, the temperature is that of the tropics, varying but little during the year from the annual mean of 79 degrees F. This uniformity causes for the white race muscular exhaustion forbidding hard manual labor, but from which the blacks of the West Indies do not suffer. The former can direct the works but the latter must execute them. Experience both on the Panama Railroad and on the Canal has shown that when the virgin soil is first disturbed much sickness is caused by the malaria thus generated, but when excavation has gone below this level to the deeper subsoil far less occurs. The hospital records of the company during the past twenty years demonstrate this fact, and the progress already made in the excavations (about two-fifths of the entire volume required) makes it evident that there is no reason for apprehending serious trouble from sickness. In this connection the matter of rainfall cannot be ignored. At Colon, on the Gulf coast, the annual precipitation is about 129 inches, in the interior about 94 inches, and on the Pacific coast about 57 inches—all well determined by observations covering many years. There is every where a clearly defined dry season of about four months available annually for specially difficult operations. Moreover, the heaviest work lies in the interior where the precipitation is comparable with, although considerably larger than that on the Gulf coast of the United States, In Nicaragua the conditions are far less favorable. The annual rainfall near the Gulf coast, where the heaviest excavations are required, appears to be about 250 inches, and there is no dry season. In the interior and on the Pacific coast much less rain falls, and there is a dry season; but even here the volume seems to exceed somewhat that in the corresponding portions of the Panama district. The matter of rainfall is of vital importance not only during the construction of the canal but also in its subsequent operation. The danger of earthquakes, very formidable for the locks of a modern ship canal, is also much greater in Nicaragua than in Panama.

The foregoing facts make apparent how different is the present condition of the Panama Canal from what it was at the formation of the new company in 1894. Its work has been continuous and rich in results. The plans are perfected, based on a thorough understanding of the subject. The route now presents no serious difficulty from an engineering point of view. The concessions are ample, and good progress has been made in actual construction. A parallel railroad, the existence of numerous quarters for laborers, and a considerable supply of tools, are available for immediate resumption of work on a grand scale. As compared with its most formidable rival, nature has given a route only about a quarter as long and requiring only about half the number of locks; an exemption from about fifty miles of river navigation which cannot but be dangerous to great ocean steamers by reason of very bad curvature and troublesome fogs and winds; and, lastly, harbors which have aided in making it the favorite transit route since the Spanish occupation four hundred years ago, meeting all the demands of commerce heretofore, and admitting of future improvements at moderate expense, should such become desirable. It seems clear that if the two canals were opened to navigation there could be no commercial competition between them, taking into account the delays and the costs of transit, including tolls, tugs for steering, etc., and insurance rates.

In fine, the present condition of the Panama Canal may be summed up as follows: The operations of the new company have demonstrated that the route possesses so great natural advantages that when completed it will control the transit of the Isthmus. The estimates of the International Commission of Engineers, representing not only France, but also England, Germany, Russia, the United States, and Colombia, have placed the costs of completion of a canal suited to all the probable needs of navigation for fifty years, and admitting of enlargement if ever desirable, at one hundred million dollars—only half of the costs of construction of the Nicaragua Canal as estimated by the Isthmian Canal Commission. The new company has everything in readiness to begin work on a grand scale, except the funds. If the United States do not care to own the route, is it to be supposed, in view of the approaching commercial struggle between the great maritime powers, that one hundred million dollars will not be forthcoming to win the prize? One of the most remunerative investments ever made by the British Government was its purchase of a controlling interest in the Suez Canal. It was a business transaction which secured the desired control without the Government appearing in the matter, except to receive interest, and which involved no outlay to be liquidated by taxation.

THE HOME ENVIRONMENT OF BRITISH WORKINGMEN.

By Percy Longmuir.

Mr. Longmuir's thoughtful study of industrial environment, though confined to British conditions, has quite too-general appropriateness everywhere. The time has come for engineering manufacturers—wherever they may be located—to arouse themselves to a perfectly clear appreciation of the fact that it is no longer practicable or profitable to ignore the physical and mental conditions under which employees, and the children of employees, must spend their lives. The era of world competition is here. In home markets, as well as in foreign markets, the fittest only can survive and prosper. And in view of the practical importance of the problem which Mr. Longmuir so lucidly discusses, we commend special attention to the editorial comment appearing elsewhere.—The Editors.

GENERAL conditions in Britain, Germany, and the United States are today receiving much attention and are being discussed from many points of view. The thought bestowed on these conditions generally results in an adverse criticism of British methods and a strong and unqualified condemnation of British trade unionism. Whilst it contains much of truth, this criticism seems unduly severe. The dominating policy of trades unionism has undoubtedly restricted the expansion of British trade; but, in all honesty, can the extremely rapid development of the United States, for instance, be traced solely to the absence of this hindrance? May there not be in addition to the restrictive union policy, other causes at work in Britain which limit progress and effectually bar advance? Is there not room for improvement in British commercial methods and in the education of employer, workman, and merchant? Are the energy and capital at present being expended on technical—and latterly, to a more limited extent, on commercial —education a necessary assurance that the right methods are being adopted? Is the present public spirit of Britain one likely to meet successfully a foreign invasion of what have hitherto been regarded as the sole preserves of British commerce or industry? Is it such as can successfully compete with foreign rivals in its own home market? Are the present conditions of British works, their management, and their workmen, such as will result in an ever-increasing standard of efficiency, combined with a low or decreasing cost of production, in an article which must meet competition in home and foreign markets alike?

Surely a long list of questions, and too many to be answered within the compass of one article; but as a solution of any one of them will contribute much to the future welfare of British industry, I propose to examine the environment—social, workshop, and educational—of perhaps the most vital element—the workmen. By such examination we may arrive at some possible means of improvement.

First, I shall endeavour to depict briefly the social environment of that lower stratum of artizans and mechanics which forms the greater part of the population in our large industrial centres. Bred and born for the most part in what thirty years hence, it is hoped, will be regarded as congested slums, the child grows or, more correctly speaking, is allowed to grow, in the same rut as its parents and grandparents. The street is its nursery, a crowded kitchen its dining room. and for sleeping accommodation it has a share of a bed in a room crowded to excess. Is it a wonder that, reared in an atmosphere of this kind, the coming artizan lacks originality, and that stamina and vital force alike are low? As evidence of the importance of physical development under present conditions, we may for a moment examine the candidates for enlistment in the regular army, quoting from Col. F. N. Maude's paper on "National Military Reform" in the *Contemporary Review*, February, 1901:—"One half of the recruits for the regular forces are rejected at the medical inspection and very many more would-be young soldiers never reach the doctor's hands at all. Making every possible allowance, it seems safe to assume that our 40,000 accepted recruits represent 100,000 applicants."

These figures give in striking emphasis a sad tale of lack of physical development, and if this is the case with the national army, what of the candidates for our vastly more important industrial army? How many of them could pass a reasonable physical standard? Surely no stronger argument can be advanced for the better environment of the industrial classes than this decay of national physique. The matter thus resolves itself into an economic necessity for the training of better specimens of humanity. Undoubtedly upon the strength and stamina of its industrial army depends to a great extent the final position assumed by the nation in the present competitive struggle.

Conditions similar to those described earlier are not familiar to the smaller manufacturing areas, but in the larger ones, and also in the larger coal-mining and iron-working communities existing as semi-towns in various parts of the country, these conditions are very real. An examination of four typical cities—say Glasgow, Manchester, Birmingham, and Sheffield—will bear out this assertion.

The education the children receive, good in its way and given in fairly well equipped schools, by efficiently trained teachers, is seriously discounted by the home surroundings, and especially by parental interference. The future working man of Britain in the majority of cases is handicapped from the day of his birth, left—if a younger child—to the care of elder brothers or sisters, allowed to get his moral training in the streets, and put to work as an errand boy or shop lad just at the time his school training is beginning to be effective. At fourteen or fifteen he is placed in works and put to a trade for which in nine cases out of ten he has no aptitude or inclination. At eighteen or twenty, little remains of his early and somewhat limited education. He marries early, rears a family in which his own training is repeated, and generally follows in the steps of his forebears. If he has any guide at all, tradition is the only one followed. Therefore, as it is traditional to regard the capitalist from an antagonistic point of view, he follows his guide most blindly in this respect, and improvements effecting increased or more economical production he regards as an indication of future lack of employment to himself or his children and therefore does his best to minimise what to him may seem a personal injury. His interests and amusements are few and do not tend to widen his scope of observation. At the theatre, maudlin sentimental plays giving a false estimate of life are his favourites; the one afternoon he has free he gives to football, and that unfortunately as a spectator and not a player; horse racing and various forms of betting complete the list. It therefore happens that the page of a daily paper most familiar to him is the sporting one, and if of a slightly developed type he may follow the police court news; but in very few cases is an attempt made to follow the policy or real progress of his own country or others. Even at an election time he makes little effort to analyse the policy of contending parties, and his vote is recorded purely on the result of emotional or traditional environment. Earnest thought or the just recognition of any particular policy are absent factors in his composition at such times. Briefly, this represents the average of the class under discussion: is it then a matter for wonder or surprise that among British industrial workers so little interest is manifested in the competitive struggle now taking place between three important nations, and that the general spirit is one of antagonism to an advancing standard?

An environment no less important than social surroundings is that of the workshop, and it must be confessed that in this respect British shops offer much scope for improvement. The actual conditions of the average workshop can hardly be classed as those likely to favour the development of the latent powers of each of its workers. Neither can the general "tone" or atmosphere be described as that likely to spur them onward or to make them keen intellectually or industrially. Robust physical development cannot be expected with workers spending the greater part of their lives in conditions such as are represented by the average shop. Good lighting and perfect sanitation are essential, yet the scant attention devoted to the latter subject may be readily noted by observation in any industrial centre in Britain. Important factors such as heating or ventilation receive but little attention, and in the majority of cases are ignored entirely.

The present tendency among large establishments to migrate to less crowded or suburban districts is, from our present point of view, highly commendable. Though as yet in its infancy, this plan has already proved entirely successful with several large firms in Britain. Land in abundance, new and up-to-date workshops of one storey only, heating and ventilation well planned, and ample conveniences for workers' comfort—such conditions are, in contrast with those presently existing, almost Utopian. It is, however, hardly necessary to urge the importance of shop environment in the pages of THE ENGINEERING MAGAZINE. The matter was fully and attractively illustrated in Mr. Patterson's article in the January issue, 1901. One further point, however, may be mentioned—that of evening study. With the adoption of sanitary conditions and conveniences that lend themselves to the worker by assisting him to perform in comfort an arduous day's work, evening study not only becomes a possibility but a pleasure. The present class of fatigued and more or less enervated evening students would, under such conditions, be replaced by a fresh and vigorous set of youths who would stimulate each other to head their respective technological ladders.

The mention of evening study brings us to the question of the present educational environment of British working men. As stated earlier, when speaking of social conditions, the education received at a public elementary school is good, but the child is removed from it at too early an age and the influence of parents and surroundings tends to obliterate the little good done. In the comparatively few cases in which evening study is taken up, the boys start far in advance of their capacity and the object sought is in most cases the acquirement of a few science certificates rather than actual scientific training. Class attendance may be fairly easy to most lads, but home study so necessary, is, by the very atmosphere of home and more or less natural disinclination, made impossible except in the case of boys possessing marked ability. Then again the daily work of many boys unfits them for serious evening work. Rising at five o'clock in the morning, as many of them must do, and undergoing a more or less arduous day's work from six to five in the evening, their inclinations naturally trend to lighter matters than study. A boy attending an automatic machine throughout the day is in far better condition physically, not of necessity mentally, for evening study than his fellow of the millwright's gang who may have been kept going with hammer, chisel, and file all day through—or than others who may have been perspiring in forge or mill and engaged on work of a peculiarly fatiguing nature. Consequently the majority of evening students come from the lighter trades. Moulders, steel or iron melters, rollers, forgemen, and kindred spirits are comparatively unrepresented, whilst the lighter branches of engineering—pattern making, building, and similar industries contribute far larger numbers of students. It therefore results that the heavier trades receive no impetus, and this fact, in combination with the decay of apprenticeship and the poorly equipped recruits entering these industries, is making the matter serious and worthy of national consideration.

Having thus briefly reviewed three divisions of environment—social, workshop, and educational—it behooves us to examine lines of possible advance, or advances that are being made by industrial pioneers. Firstly, the attention now being devoted by municipalities in many large centres to housing problems will, it is to be hoped, fructify in much useful reform in this direction. Naturally the most tempting solution lies in the opening out of suburban districts, with the adoption of rapid and regular modes of transit between these districts and the hearts of the towns. Away from the congested areas of town life the development of children might proceed on more childlike lines and the present stunted and preternaturally sharp growth be replaced by a vigorous, full-chested class of healthy children, who at a later age would view industrial life with normal eyes and a fair sense of proportion.

Before passing on to education, a few words on parental influence are in keeping with our subject. The view taken by the rank and file of the working classes, that children should be a source of profit at the earliest possible moment, must be combatted, and if no other method avail, be exterminated by government interference. Children who, almost the very day they are exempt from school attendance, are put" to help to earn their keep" as the parents express it,are not the best augury for the future capacity, as a whole, of the working forces. All forms of child labour, whether as "half-timers" or workers out of school hours, are too great a strain on our credit account and are economically unsound. A further matter of note is that the more squalid the parental surroundings the more numerous the progeny. Not admitting the truth of Zola's views as set forth in "Fécondité," we are nevertheless bound to admit that an improvement in quality would admit of a decrease in quantity and at the same time give the parents more opportunity to realise their responsibilities.

The age limit of children leaving elementary schools might be profitably fixed at fourteen, and attendance up to that age made compulsory irrespective of the child's attainments. If to this could be added the universal adoption of the metric system,* thereby saving two years in every child's school life, we should indeed be approaching something of excellence in our system of education. The school training should be general and most thorough; it should put the child in such a position that in later life he can reason from the data around him: in short, the whole aim should be to develop to the fullest extent the child's thinking powers. The training, whilst wide and thorough, should not attempt too much or in any way imitate certain higher grade schools which make a practice of overburdening the children with a mass of ill-digested and ill-assorted scientific and other lore, and an inkling of mathematics in addition to a foreign language or so. In the first place, due importance must be given to the three R's. Put the children in the way of realising their own literature and teach them to follow intelligently the progress of their own country. History and comparative geography give exact information and at the same time put the child in a position to reason out cause and effect for himself. He can then grasp the position of his own and other nations, and such a training is of far greater utility to a working lad than a smattering of another language which he never has time to master nor opportunity to apply, with the consequence that he soon loses the little he has acquired. With regard to the sciences, it is better far to attempt few and those thoroughly; therefore chemistry, the "grammar of science," is recommended, and let the training in this branch be thorough and practical—the reverse of cramming. Freehand and model drawing, with mathematics, complete a syllabus sufficiently full. A boy so trained, on applying for work in his fifteenth year, is in the possession of a sound elementary education—not a higher-grade prodigy by any means, but a common-sense training that will be of benefit to him in every stage of his industrial career. His tastes in literature have been directed and he has been taught how to get the best out of a book, and is therefore in a position to obtain full benefit from the technical books or papers treating of his particular industry. The estimation of cause and effect, chemical knowledge, and skill in drawing, are all rungs in the boy's ascent of his industrial ladder. Having been taught the use of his faculties, such a boy all through life would keep in touch with the moving spirit of the age. Competition to him would be but an incentive to further effort. An army composed of such units would not mar its own advance by opposing new ideas and labour-saving improvements.

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* This interesting suggestion brings up the point that it is the decimal system, rather than the metric unit, which constitutes the labour-saving feature of the French and German weights, measures, and currency. In the United States a large proportion of the advantage indicated by Mr. Longmuir is secured without any radical change of standards. The measures of weight and dimension are in general the old English ones, with elimination of a number of intermediate and unnecessary denominations; but the fractional subdivisions, in engineering work, at least, are expressed in decimals. The civil engineer speaks of feet and hundredths, the mechanical engineer of inches and thousandths. The benefits of decimal notation are secured without the upheaval involved in the adoption of the not-too-convenient metric standards.—The Editors.

Evening classes under these conditions assume less importance, for the boy, having been taught the use of his brain, is continually assimilating. The chief aim of evening classes then would be to minimise the delimitation of apprenticeship; the instruction given would savour more of a technological than a technical character, and the motive (which presently is the acquiring of certificates) would become actual training. The beneficial effect of such a training cannot be overestimated.

In advocating workship reform the capitalist naturally wishes to know if this expenditure on such matters as sanitation and ventilation will be justified by results; in short, will it pay so to better the conditions of the workshop? Undoubtedly; for in the first place this outlay on the comfort of his factories results in better and more uniform production of work. The best type of workmen seek employment in such factories, and an employer so situated can in the busiest of seasons ever make his pick of skilled labour. Labour troubles are of comparatively rare occurrence in establishments which to some extent consider the comfort and convenience of their workers. Secondly, and of far greater moment, better men are trained to fill the ranks of the industrial army, men who recognise their responsibilities and duties—more than that, fulfil them; who, when an arduous day's work is performed in comfort, have sufficient energy left to study the difficulties of their trade and the progress of their industry. Sound training, healthy and congenial home surroundings, and active employment in sanitary workshops, will contribute much towards removing discontent and unhappiness. Such influences and surroundings would result in a community famed for its zeal and always in the forefront of the march of progress.

In advocating any system of reform essentials must not be lost sight of, and in this article the aim has been to describe the "fittest" to fill the ranks of industry. The environment at present existing is no adamantine one; the remedies are at hand and only strenuous persistence is needed to carry them through.

Of the many outlets for reform I have noticed only three—reform of workshop, home, education, the preparation for industrial life, and inherent reform in the workman himself. One is reluctantly compelled to admit that reform in the last case is the most urgent and will be most difficult of achievement. This will be effected chiefly by the influence of the recruits. Trained in the use of their faculties as already indicated, their entrance into the industrial masses would in course of time gradually leaven the whole. Such a revolution is a necessary factor in the progress of the nation, and if Britain means to maintain her position as a paramount power, she must sweep away much conservative tradition and educate alike workman and employer to a full sense of responsibility and duty.

MODERN IRON BLAST-FURNACE PRACTICE.

By Frank Hearne Crockard.

Mr. Crockard's article, based largely on American practice, is particularly interesting in view of Mr. Phillips' recent full review in these pages of British iron and steel making and American and German competition. Supplementing Mr. Hatch's description of the transportation methods evolved in connection with the movement of ores from the region of the Great Lakes, Mr. Crockard follows the handling of the crude materials from the stockyards to the furnace, and through it to the finished pig. It is a remarkable study in the application of machinery to meeting the ever-growing demand for more iron and cheaper iron—a demand which the rapid extension of machinery and mechanical methods everywhere has itself created.
The Editors.

THE last three decades have been epochal in American blast-furnace practice and construction. The Lucy furnace of Pittsburg may be named as the primordial furnace of the present type. This furnace in the year 1878 had a cubic capacity of 15,400 feet, and was driven at the rate of 16,000 cubic feet of air per minute. The results of the first year showed a daily production of 91 tons, so that each ton of iron required 169 cubic feet of furnace volume. The coke consumption during this period averaged 2,850 pounds per ton of iron. The promising bud of siderurgical progress thus started reserved a later day for blossoming, and this we find in the Edgar Thomson furnace "blown in" during April, 1880. Furnace B of this group (Figure 1) was 80 feet high, and contained 17,868 cubic feet. The hearth measured 11 feet in diameter and was fitted with eight 5½-inch bronze tuyeres, through which were forced 30,000 cubic feet of air per minute, at a temperature averaging 1,100 degrees Fahrenheit. This furnace produced 132 tons daily, requiring 135 cubic feet of furnace volume per ton of iron. The coke consumption during this period averaged 2,859 pounds. Small as they now seem, these tonnage records were regarded as phenomenal, if not incredible. This period was distinctively, therefore, one of rapid driving, wonderful production, and high fuel, and so continued until the blowing in of the

North Chicago Rolling Mill Company's Number 7 furnace. (Figure 4). This furnace was blown in during March, 1885; for the period covering the last six months of that year the production aggregated 36,680 tons, the average coke for the same period falling to 1,912 pounds per ton of iron; the rate of driving, which averaged from 22,000 to 25,000 cubic feet of air per minute the previous year, had now fallen to 16,000 cubic feet. This achievement marked the next important step, characterizing the period as one of great production, low fuel, and slow driving. While these results were very gratifying, they proved merely precursory of the greater achievements of the new epoch which has since been seemingly resolved into an interminable era.

In September, 1889, the Edgar Thomson group again forged to the front with the blowing in of an 80-foot stack, containing 18,200 cubic feet (Figure 2). This furnace had seven 6-inch tuyeres delivering 25,000 cubic feet of air per minute—a return to the figures of 1880, but productive of entirely different results. The temperature of the entering blast remained about the same, 1,100 degrees Fahrenheit, but the pressure had reached 9½ pounds, while the output (for the month of April, 1890) reached 10,075 tons on a coke consumption of 1,884 pounds. In 1880, 135 cubic feet of furnace volume were required per ton of product; in 1890, this figure had fallen to less than 60 cubic feet. Intensity of production was the order of the day, and, thanks to the daring initiative of American metallurgists, has not yet found its prescribed limits.

An interesting example of recent furnace construction is found in the Youngstown plant of the National Steel Co.

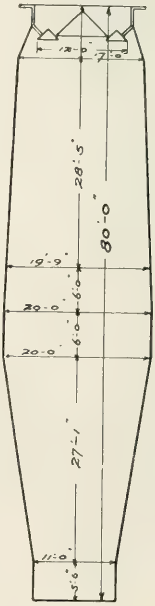

FIG. 1.

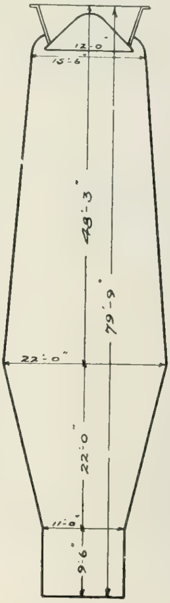

FIG. 2.

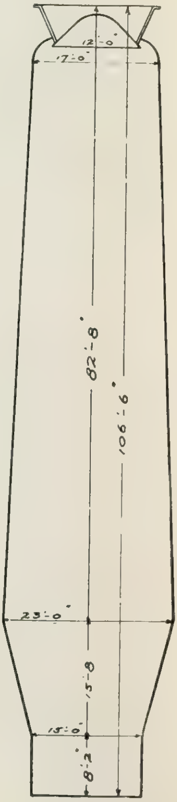

FIG 3.

These furnaces are 106½ feet high, 23 feet in the bosh, and have a hearth diameter of 15 feet, giving a capacity of 26,500 cubic feet (Figure 3). Blast at the rate of 50,000 to 60,000 cubic feet per minute is introduced through sixteen 6-inch tuyeres. The normal pressure is about 15 pounds, but the blowing equipment is designed to furnish 25 pounds when necessary. These furnaces were blown in during 1900; in the month of October of that year one furnace produced 17,600 tons with a fuel consumption of 1,777 pounds per ton; a second stack during the same period produced 17,412 tons with a fuel consumption of 1,790 pounds. Both furnaces lost a day during the month. Comment on these magnificent figures is not necessary.*

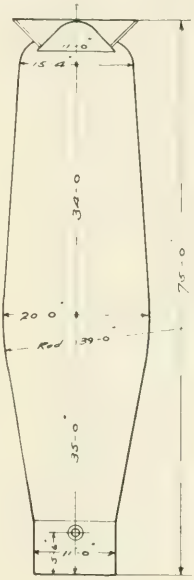

FIG. 4.

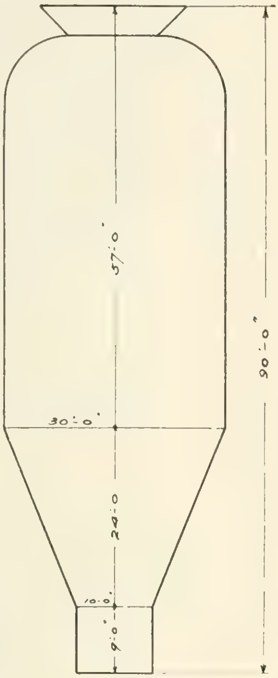

FIG. 5.

While it is true that furnaces of greater (cubic) capacity than the present American furnaces were constructed as early as 1870 as for example the two Ormesby (English) furnaces constructed about that period, which are represented in Figure 5, which had a volume of about 40,000 cubic feet, as compared with 26,500 cubic feet in the case of the Youngstown furnaces, we find their weekly output equalled by the daily product of the latter. The development, then, of the high-pressure, high-tonnage furnace, as we understand the term to-day, has been accomplished during the last ten years. With this increased tonnage, the demand—or rather, the necessity—for apparatus supplementing or displacing manual labor grew apace. When we remember that the digestive capacity of one of these monsters, expressed in tons, approximates 2,000 tons daily, the task of supplying

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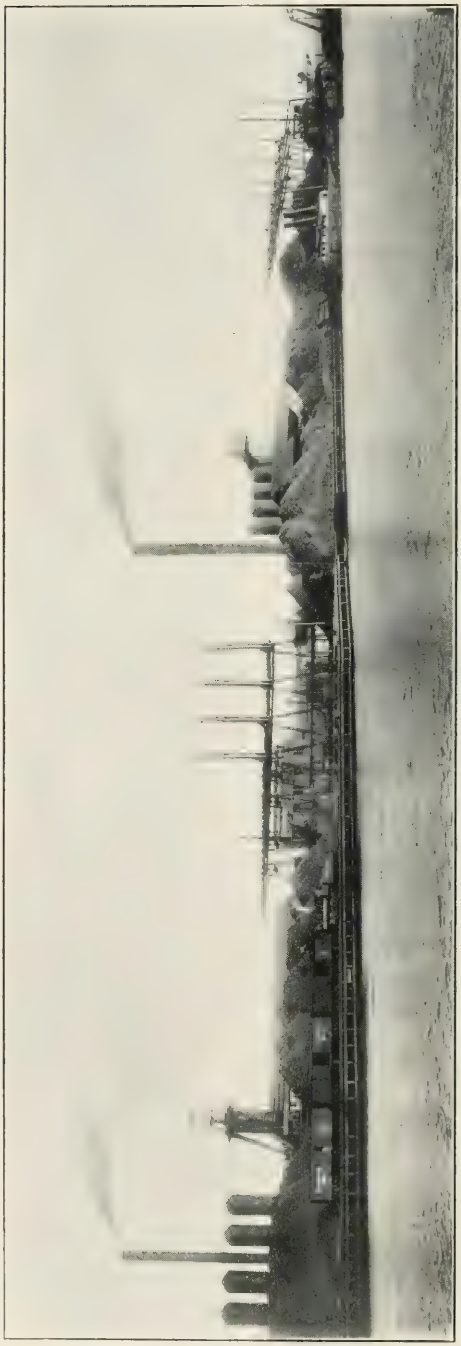
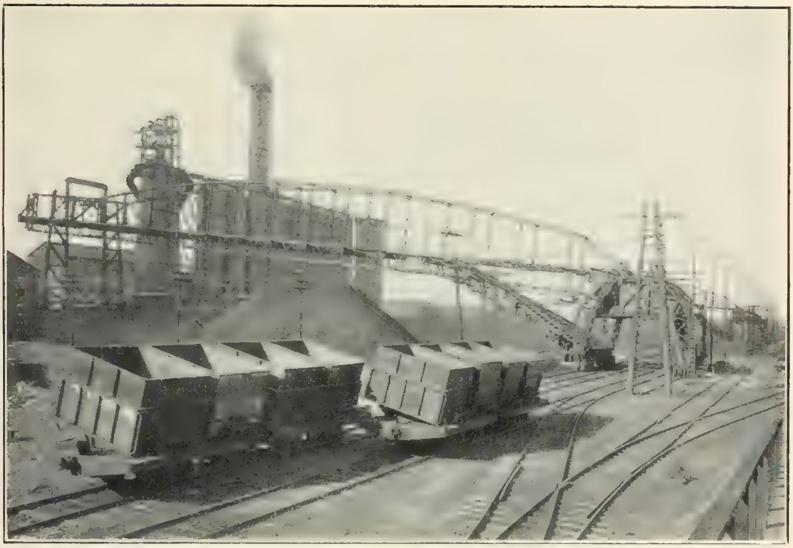
* Since writing this article one of the Carrie furnaces at Rankine, Pa., has established a new world's record by producing 780 tons for a day's work; as this is a new furnace we may expect to hear of the 800-ton mark being exceeded shortly.—F. H. C.



GENERAL VIEW OF THE PLANT OF THE IROQUOIS IRON COMPANY, CHICAGO.

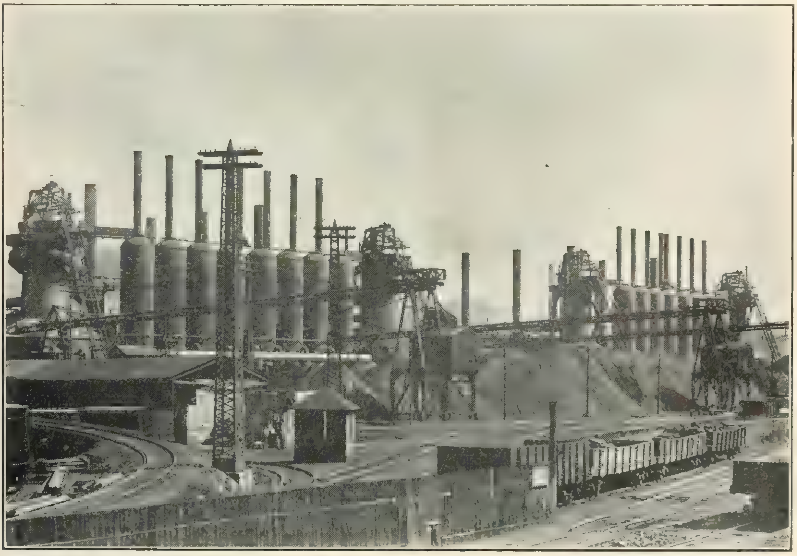
its capacious maw is more fully appreciated.

The Duquesne plant of the Carnegie Steel Co. was one of the first examples of this type. A 600,000-ton stock yard, 1,085 feet long, having an effective width of 226 feet, was provided for the four furnaces comprising this group. The stock yard is spanned by three bridge cranes built by the Brown Hoisting Machinery Co. of Cleveland. During the stocking season, hopper-bottom cars are unloaded in bins behind the ore piles seen in the photograph on the opposite page. These bins form one of two parallel rows; the row nearer the furnaces is used for supplying immediate demands, while the row facing the stock pile is used for transferring the ore from the cars to the ore buckets, which when filled are picked up by the crane and automatically dumped on the stock piles. The reverse operation is accomplished by means of 5-ton drag buckets, which pick up the ore from the face of the pile, delivering it either into the bins or bin-filling cars as may be desired. The cars so loaded are then placed over the



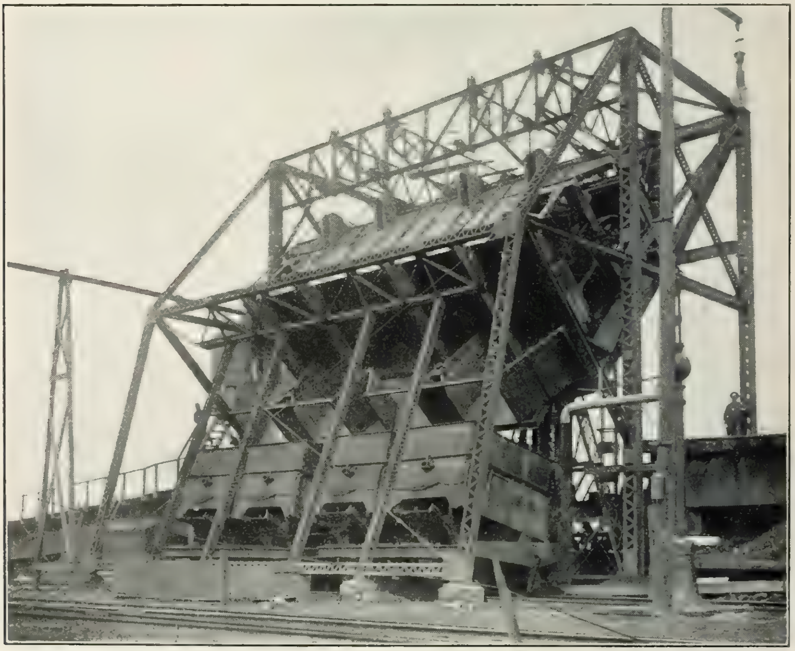
HULETT ORE BRIDGE, NATIONAL STEEL COMPANY'S PLANT, YOUNGSTOWN, OHIO.
Webster, Camp & Lane Machine Co.

proper bins and there unloaded—the bottoms dropped. A more recent plan is that adopted at Neville Island, Mingo Junction, and Youngstown. The photograph just above shows a Hulett ore bridge as built



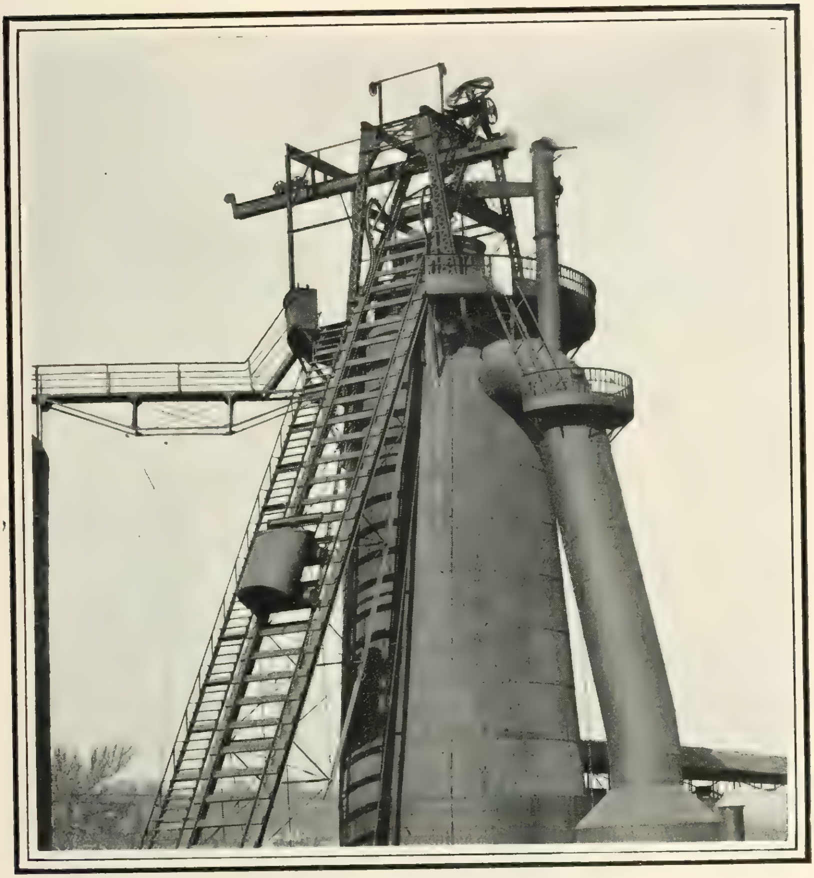
DUQUESNE BLAST FURNACES, CARNEGIE STEEL COMPANY, CAPACITY 800,000 TONS ANNUALLY.
The ore bridges are shown in the foreground.

by Webster, Camp & Lane, of Akron, Ohio. The clear span is 260 feet, with a cantilever extension of 41 feet commanding the ore bins. The method of handling the ore with this system may be briefly outlined as follows: The ore car, which may be either gondola or hopper, is placed on the dumping machine, shown below; when in position, the car is rotated through an arc sufficient to cause a free flow of the ore, which in passing through the chutes is deflected into four side-dumping bridge cars mounted on a transfer car as shown. These bridge cars have a capacity of 17 to 20 tons, and the car dumper will easily handle 15 cars of ore hourly. The transfer car is then moved under the machinery tower of the conveyor bridge, where by means of a cable the bridge cars are pulled up on one of four converging tracks to the through bridge track and automatically dumped at any desired point, either in the stock yard or furnace bins. In taking ore from the stock pile to the bins or bin-filling cars two methods may be used, and in both cases the buckets are operated by the motors operating the bridge cars. A second track, suspended below the main track, carries a trolley to which is attached a scraper bucket (as at Duquesne) holding about 10 tons;



HULETT CAR-DUMPING MACHINE, FOR HANDLING FULL CARLOADS OF ORE. NATIONAL STEEL COMPANY'S PLANT, YOUNGSTOWN, OHIO.

Built by Webster, Camp & Lane Co., Akron, Ohio.



FURNACE-TOP CHARGING APPARATUS.
Built by Brown Hoisting Machinery Co.

about 15 buckets per hour can be taken from the pile to the bin-filling cars. In the second method, a two-part grapple bucket holding about 12,000 pounds of ore is used; 25 to 30 buckets are handled hourly by this arrangement. As the bucket operates vertically, it has the advantage of working in the centre of the ore pile, where trouble from the frost will be less than working on the outside of the pile. The cost of transferring ore from the cars to the stock pile with the Hulett bridge is said to be less than one cent per ton.

The ore now being in stock, the next step is to get it to the furnace. In the case of the larger furnaces the vertical hoist tower carrying its cumbersome charging barrows was found to be a slow and costly method and has been superseded by the skip-way or incline. The ore train, handled by a small locomotive running on tracks placed be-

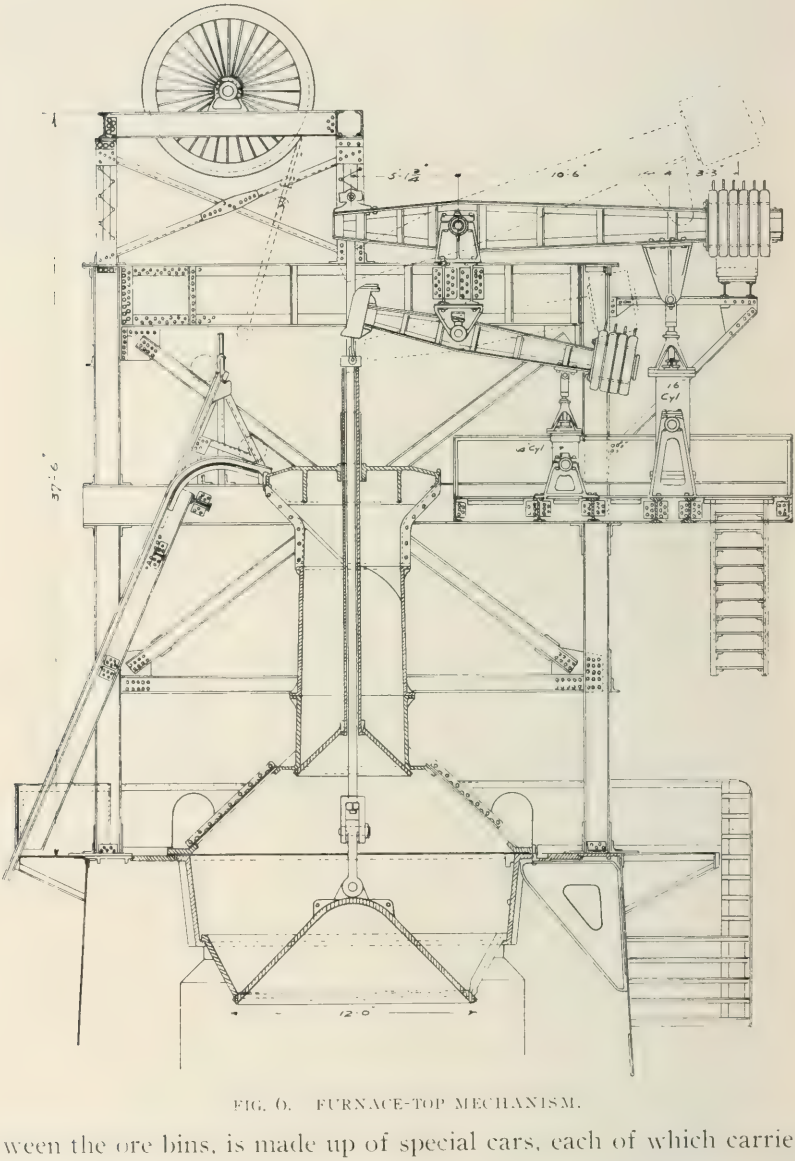
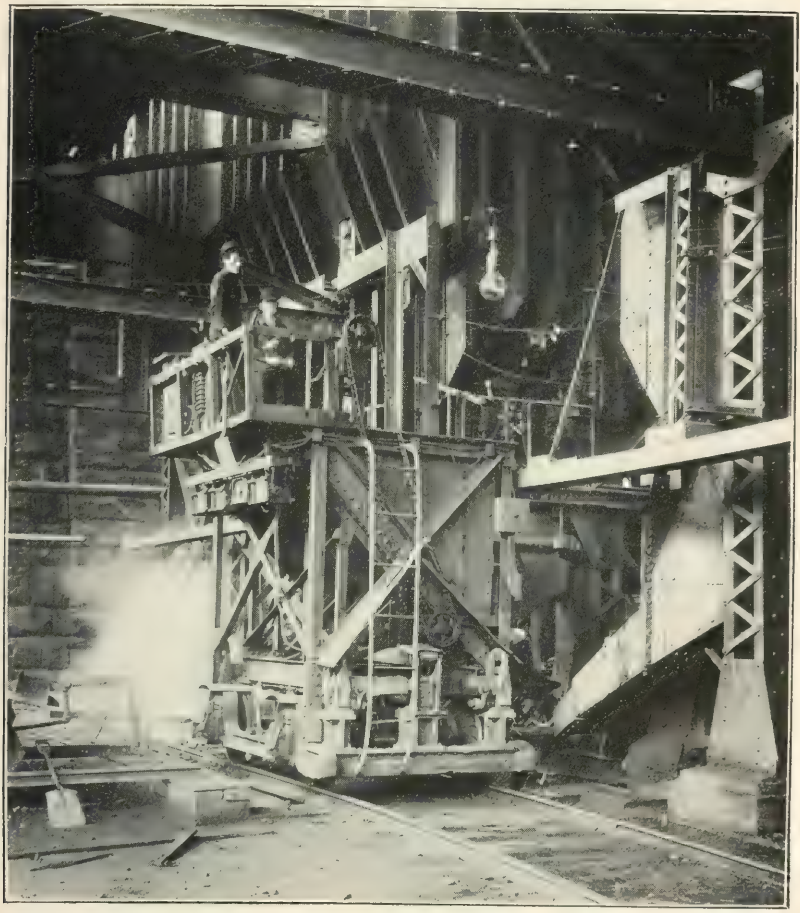


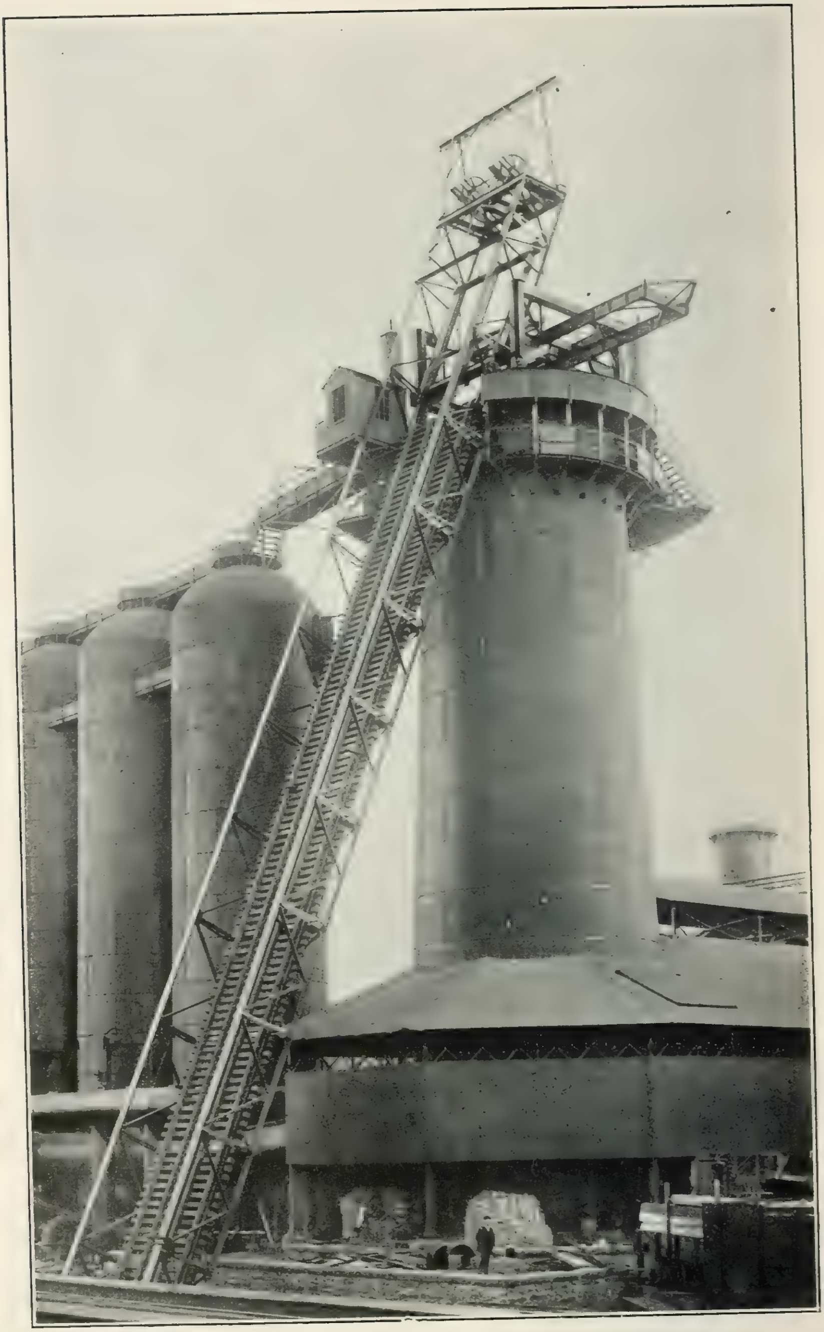
FIG. 6. FURNACE-TOP MECHANISM.

tween the ore bins, is made up of special cars, each of which carries a charging scale, on which rests the ore bucket capable of holding 10,000 pounds of ore. These buckets, when properly filled with the required kinds and quantities of ore, are pushed under the incline. The central bucket rod, pendant from which is an iron cone or bell closing the bottom of the bucket, is now grasped by a bifurcated hook hanging from the incline carriage; from this point they are rapidly carried to the furnace top and there quickly emptied by lowering the bell forming the bottom of the bucket. This very ingenious arrangement is in use only at Duquesne; possibly a more typical furnace top is that in use at the Youngstown furnaces, shown in



ELECTRICALLY OPERATED SKIP-FILLING OR SCALE CAR, NATIONAL STEEL WORKS, YOUNGSTOWN, OHIO.

cross section in Figure 6. Before considering the top, however, let us first take up the method of assembling the burden. In the photograph just above is shown the skip-filling car, which commands the full length of the ore bins. As will be noticed, it is a side-dumping car electrically operated and carrying its own scales. This car delivers the ore from the bins directly to the skip car, which rests in a watertight tank immediately in front of the car. The limestone is delivered

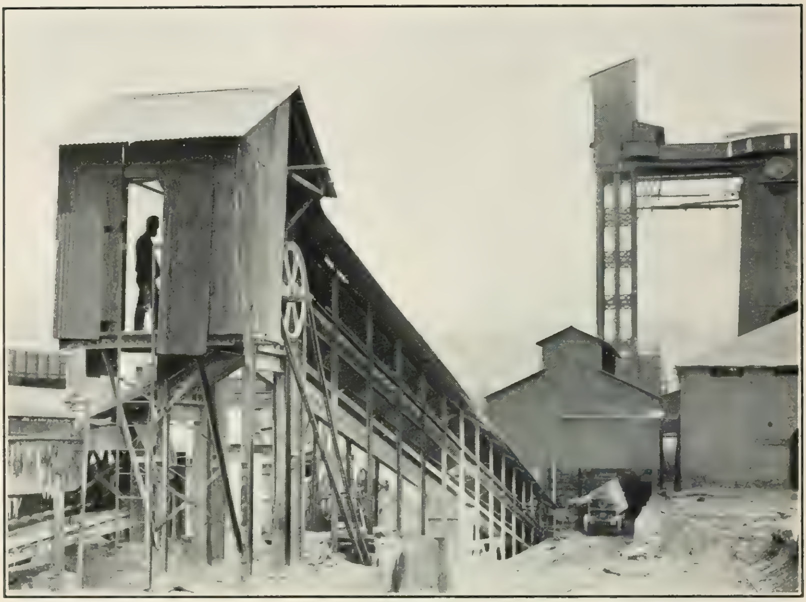


FURNACE NO. 2, WARWICK IRON & STEEL CO., POTTSTOWN, PA.

Showing skipway and furnace top. This top is similar to that shown in the general view of the Jones & Laughlins plant.

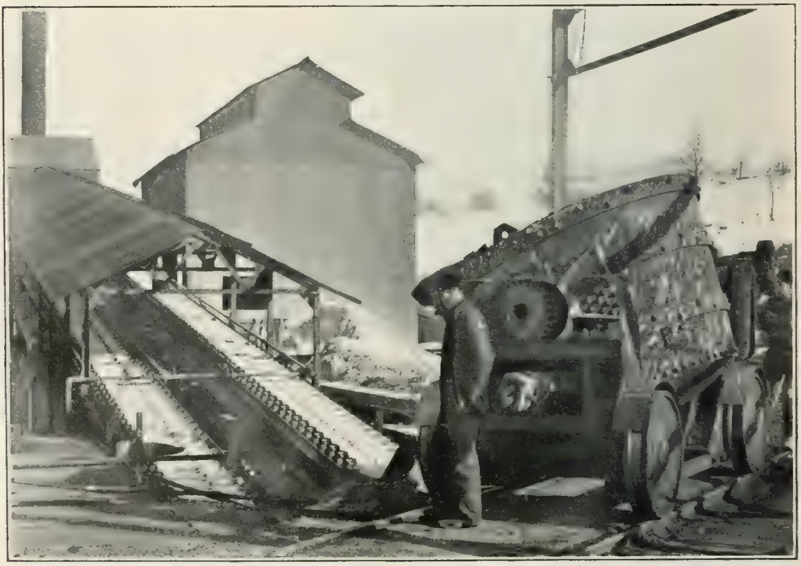
from the bin shown to the right directly into the skip car, while the coke is also delivered directly into the skip from the bin shown to the left. The skip, holding about 15,000 pounds of ore, is now carried to the top of the furnace where it is discharged into the receiving or supplementary hopper which is designed to hold a skip load. The small bell closing this hopper is now lowered by means of the 14-inch oscillating cylinder actuating a counter-weighted beam; the descending column of ore is evenly distributed around the main furnace hopper, which holds a 30,000-pound ore charge; this bell is operated by the 16-inch cylinder. It will be observed that the bell rod of the small bell is hollow and through it passes the solid rod of the large bell. In operating this arrangement the upper bell is always closed during the period the lower bell is discharging stock into the furnace; the seal so formed prevents the waste of the furnace gases. The view on page 499 shows another top charging apparatus, as built by the Brown Hoisting Machinery Co. In this case the skip dumps into a central receiving hopper carrying an inclined spout, which delivers the ore at any given point on the periphery of the bell; as successive charges are dumped into this receiving hopper, it is caused to rotate through any desired angle. It is evident that a furnace charged in this manner closely approaches the hand-filled furnace so far as fa-

FURNACES OF THE WOODSTOCK IRON WORKS, ANNISTON, ALA.



UEHLING CASTING MACHINE, DISCHARGING END, STRUTHERS FURNACE, OHIO.

The pigs, falling from the upper end of the strand, drop into the chute below the figure of the operative, and thence into the water tank. The ladle is shown in pouring position at the lower end.



TOP VIEW OF MOULDS, UEHLING CASTING MACHINE, CARRIE FURNACE, RANKINE, PA.

cility of controlling stock distribution on the bell is concerned. Skips are operated by steam or electricity; in either case an automatic slowing device is used which causes the skip to come to rest gradually and without shock.

Another interesting part of the equipment of the modern blast furnace is the casting machine. In dealing with the heavy tonnage involved it was found necessary to have a quicker and more reliable, as well as a cheaper and less laborious, method of handling the iron than that afforded by the old system of casting in pig beds. To meet this demand several well-known machines have been devised, one of which, the Uehling, is shown in the photograph as built by the American Casting Machine Co., at the Edgar Thomson works. The pigs weigh from 110 to 115 pounds, and being free from sand are much more acceptable than the sand-laden pigs of our fore-fathers.

UEHLING CASTING MACHINE AT THE EDGAR THOMSON WORKS.

Slag machines of the Hawdon type have also been installed in several plants where the local conditions seemed to warrant this particular method of slag disposal. As long as the slag dump affords sufficient room, the ladle car will likely continue as the cheapest and quickest method of disposing of what is still very largely a waste product. In this connection it is interesting to note that several furnace plants, notably the Illinois Steel Co., are making a high-grade Portland cement from their furnace slag.

Another feature of the modern furnace deserving special mention is the water-cooled bosh plate. As late as 1890 we could not point to a single furnace which had produced 250,000 tons during the life of a lining; to-day we have records exceeding 1,000,000 tons. Early experiments with water-cooled cast-iron plates built into the bosh walls demonstrated the efficiency of this method of preserving bosh walls. These iron blocks were, however, rather difficult to replace when making renewals, and as a result of continued efforts toward improvement along these lines we have to-day several well-known forms of

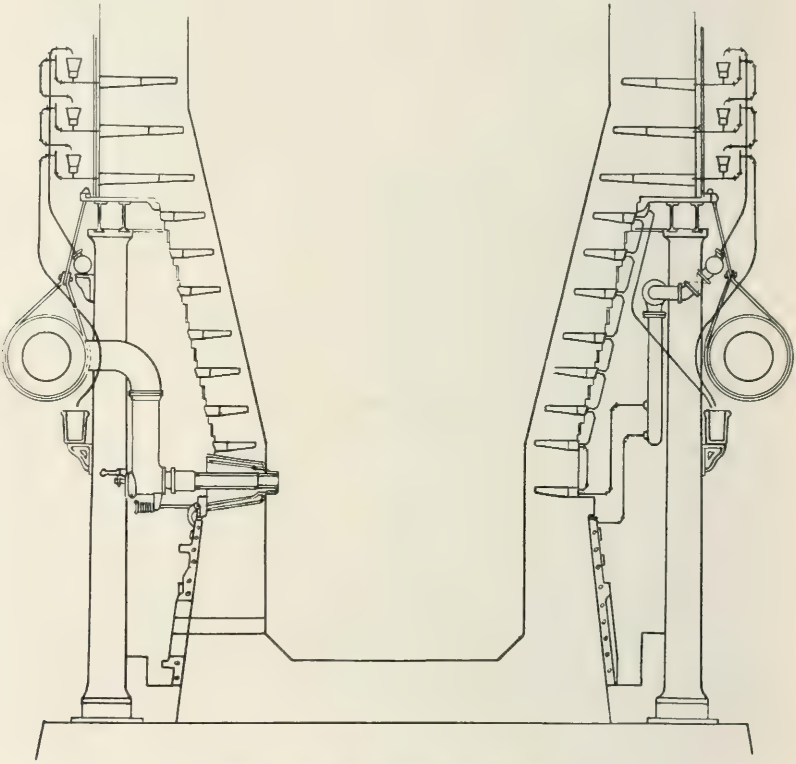
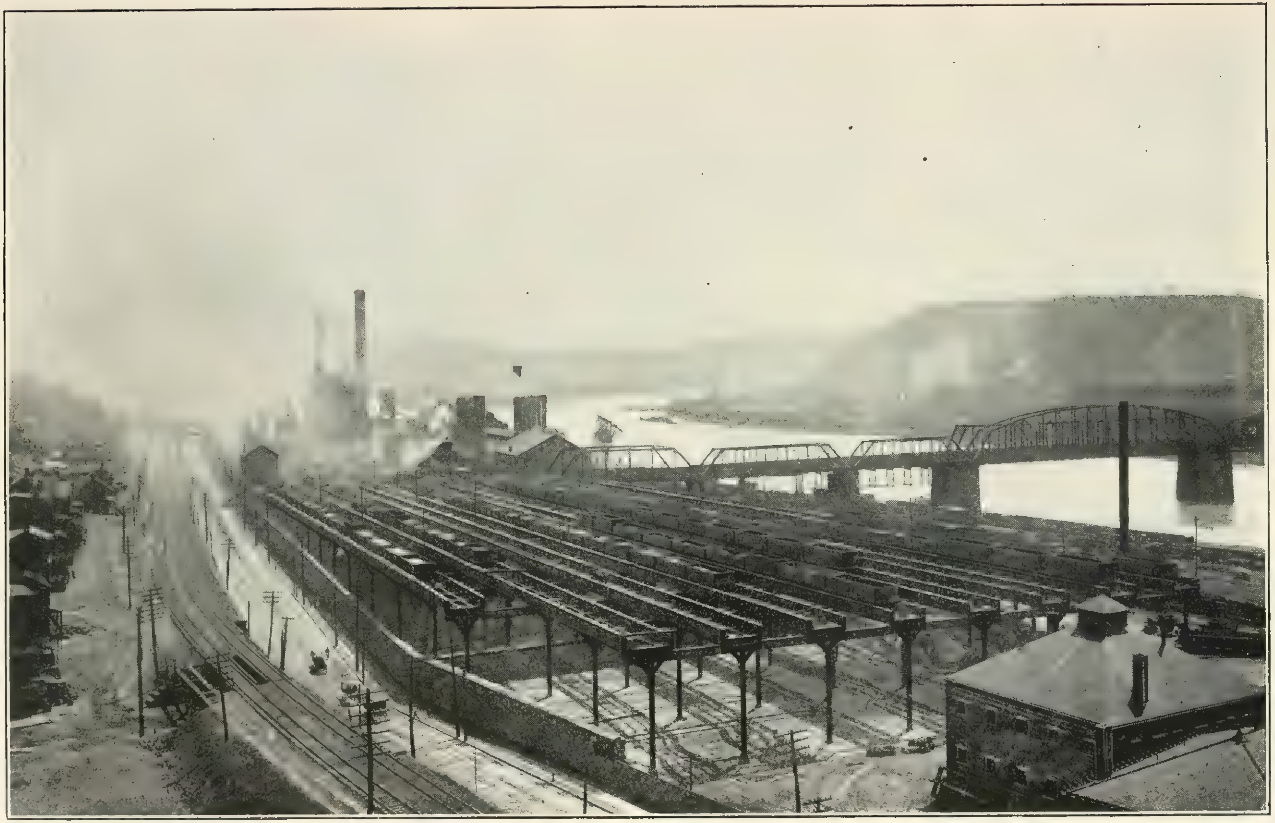


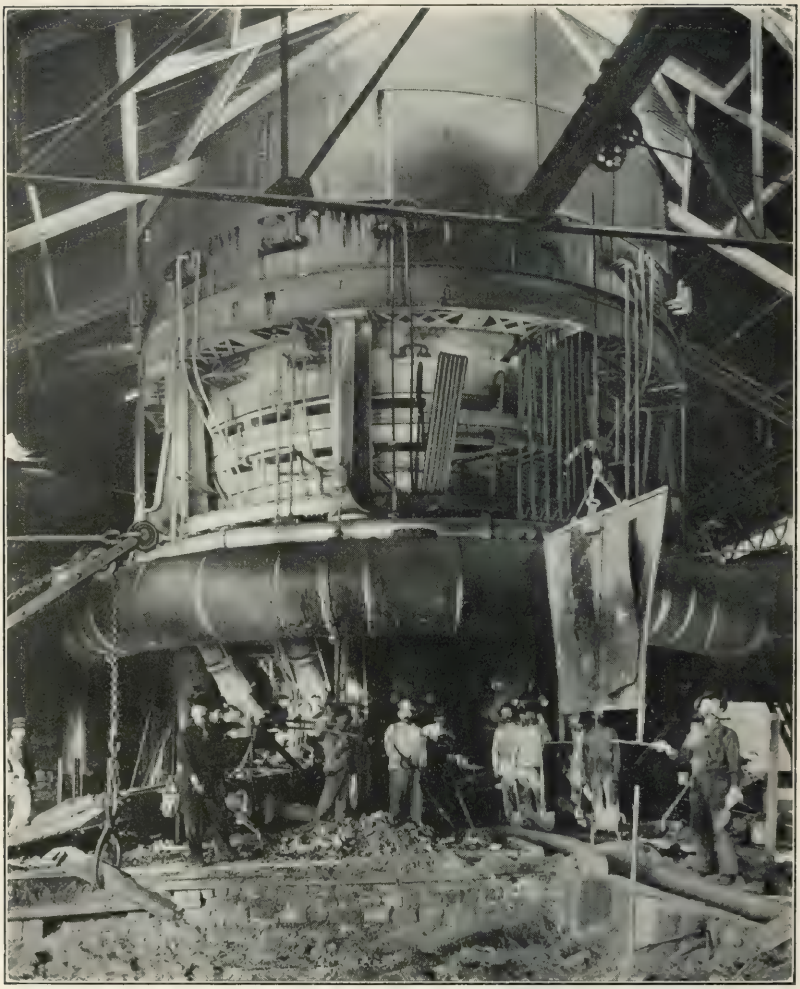
FIG. 7. WATER-COOLED BOSH WALLS.

bronze or copper bosh plates, which are built into the bosh walls as shown in Figure 7. In the case of the well-known Scott plate they are built into the walls with a relieving arch of brick thrown over each plate. In other cases, as with the Gayley, these arches are dispensed with. In more recent practice an iron arch or socket plate which acts as a holder for the water block has been adopted. The large plates formerly used have given way to a greater number of smaller plates; the total amount of copper in a given furnace is not increased by this arrangement, but a more thoroughly protected bosh is the result. At the tuyere belt these plates are placed a minimum distance apart (vertically) usually just far enough to allow the proper space for the thick-



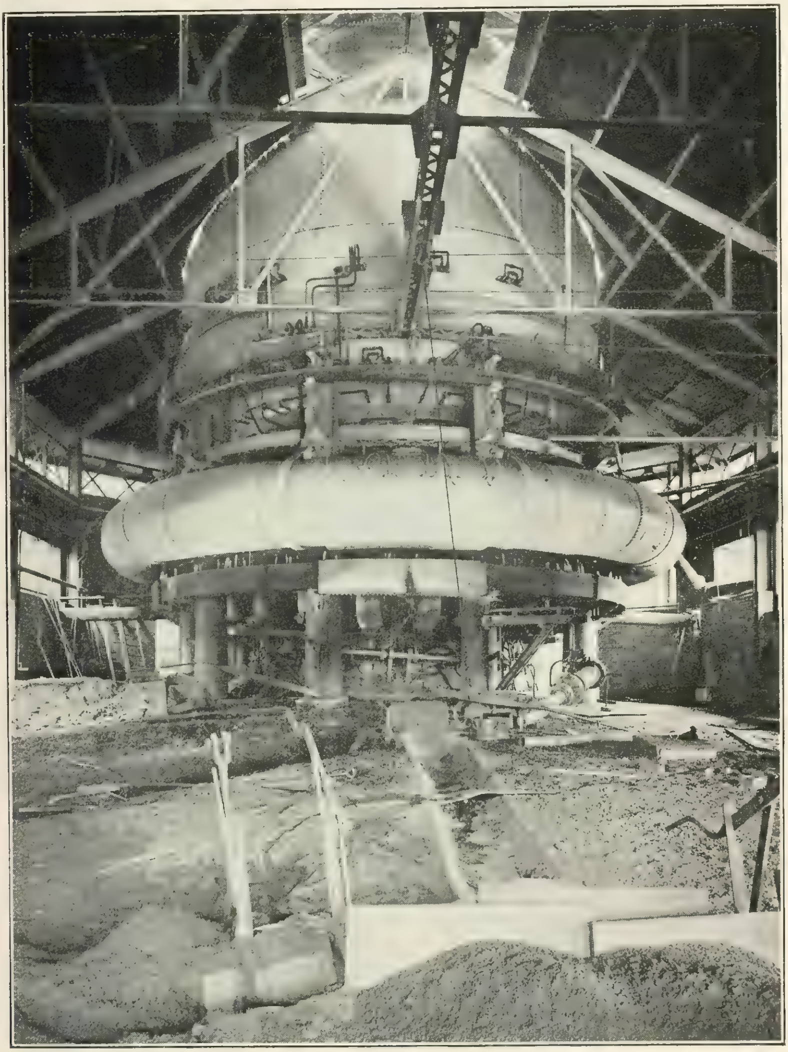
HOT-METAL BRIDGE AND 600,000-TON STOCK YARD, JONES & LAUGHLINS, PITTSBURG.

Steam shovels load the ore from stock pile into hopper-bottom cars which deliver the ore to the furnace bins as required

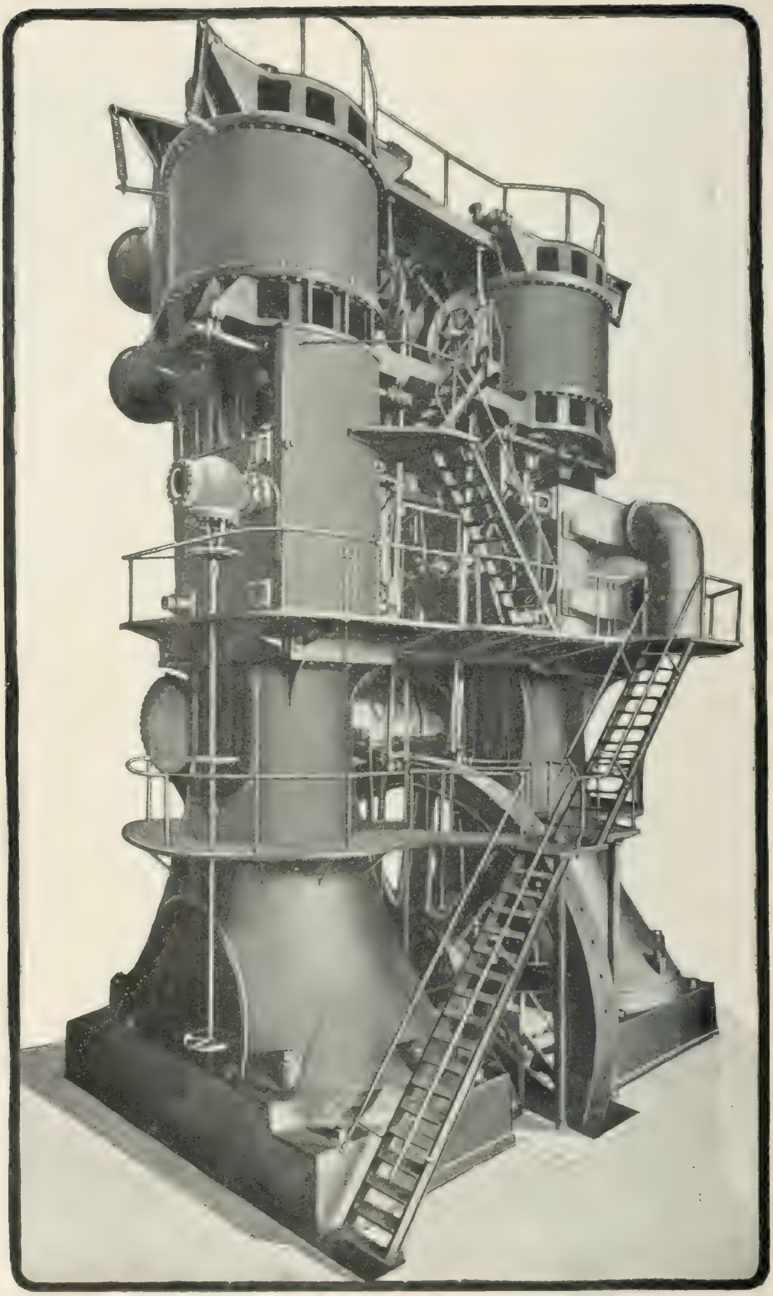


FRONT VIEW OF NO. 3 FURNACE, LEBANON, PA., SHOWING ARRANGEMENT OF BOSH PLATES.

ness of the socket plates and the depth of the bosh bands. As we leave this region of intense heat and approach the top of the bosh, the plates are gradually spaced farther apart. A circular feed line carrying water at 10 to 30 pounds pressure supplies the legs or manifolds placed at each column (Figure 7). The water is conducted from these manifolds to the lowest row of plates and allowed to ascend through the series, finally discharging into the water trough. Above the mantle plate it is desirable to use a gravity feed instead of pressure; the idea is clearly shown in the sketch. The hearth is protected by a heavy steel jacket cooled by a water spray, or a cast-iron jacket built up in sections each of which carries a coil of pipe through which the cooling water circulates. With the increased bosh life it was found necessary to protect the brick work forming the throat of the furnace in order that both top and bottom might "die" together. In some instances water-cooled blocks have been used for this purpose, but this seems a needless refinement, since a series of cast-iron plates



FRONT VIEW NO. 3 FURNACE, JONES & LAUGHLINS.
The Vaughn notch-gun is seen hanging from a crane.

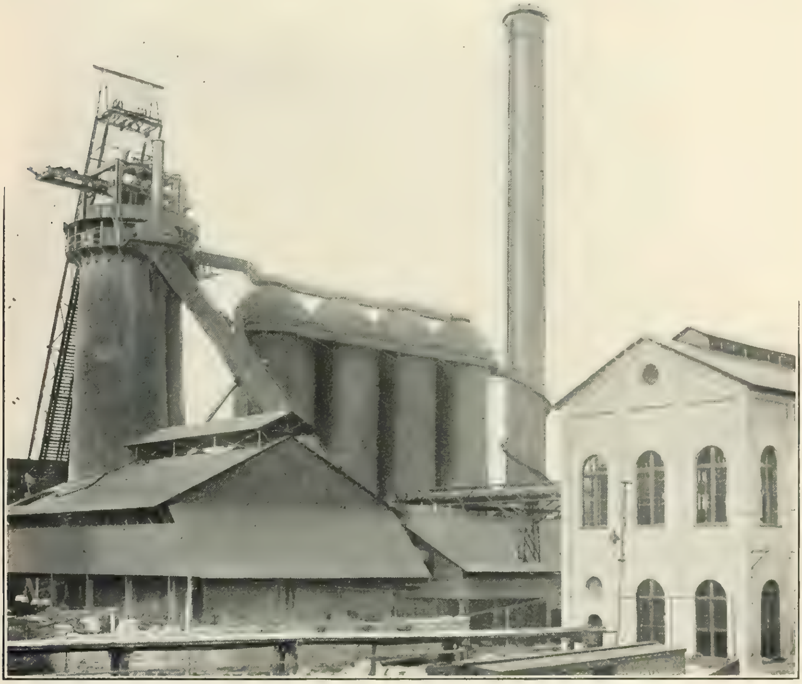


VERTICAL STEEPLE CROSS-COMPOUND BLOWING ENGINE, NATIONAL STEEL CO., YOUNGSTOWN, OHIO.

Cylinders 54, 102, 108, and 108 inches by 60 inches. Capacity 60,000 cubic feet of free air per minute. Weight 635 tons. Built by The Wm. Tod Company, Youngstown, Ohio.

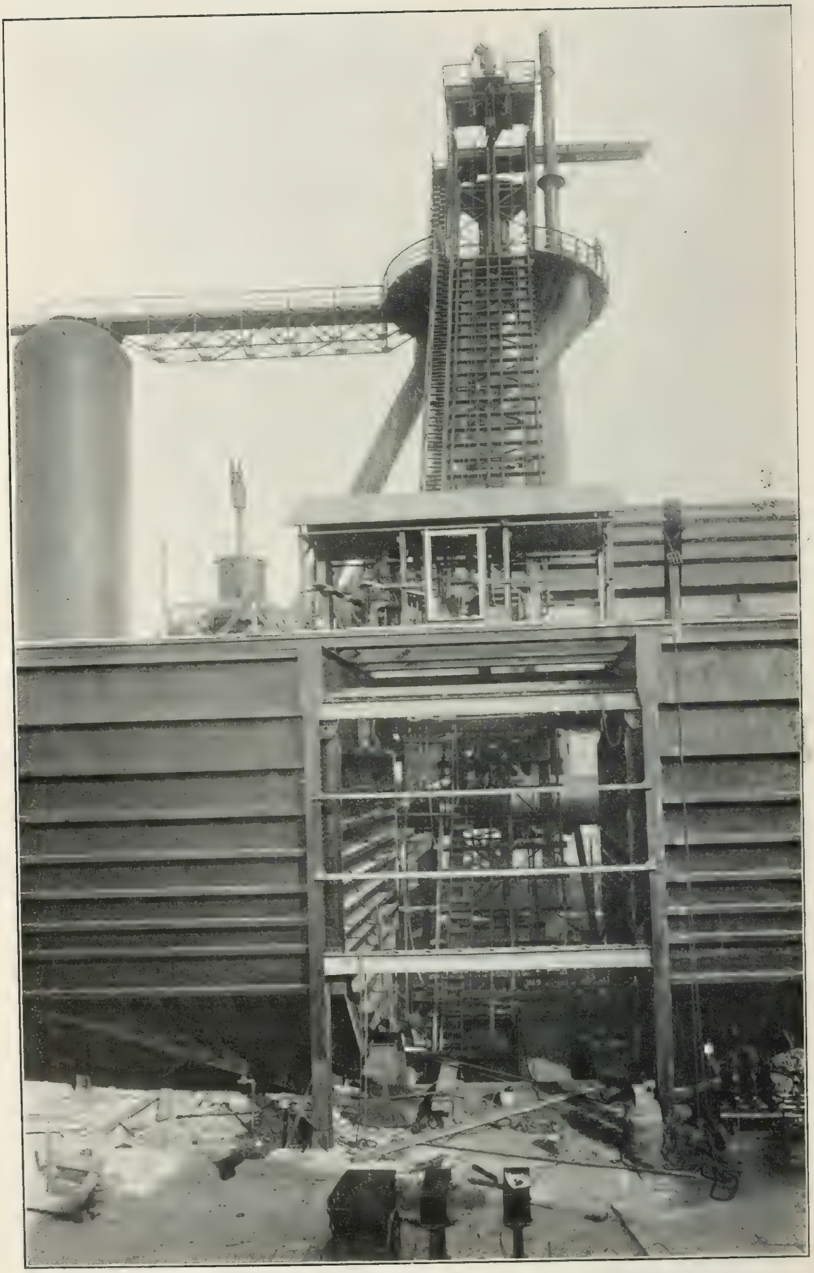
properly arranged will furnish all needed protection for this portion of the furnace.

The scope of this article will scarcely permit more than a reference to the hot-blast stoves of the modern furnace; with these the evolutionary process has been chiefly one affecting size rather than one causing any radical changes in former well-known designs of the regenerative type. Some of the recent stoves have been built 21 feet in diameter and 118 feet high..

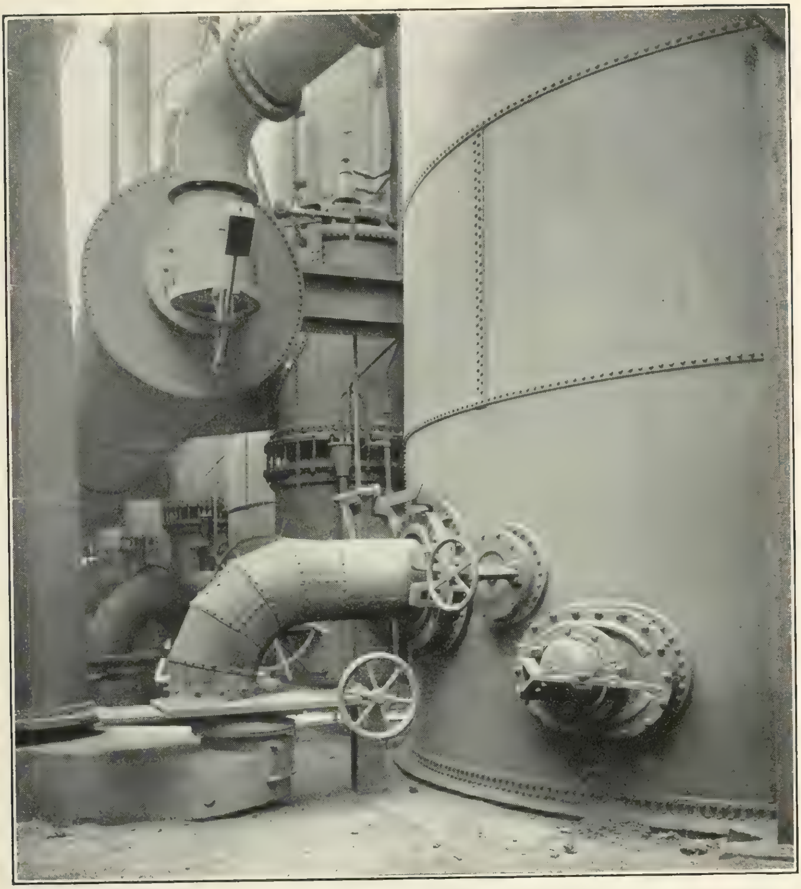


WARWICK IRON & STEEL COMPANY'S NO. 2 FURNACE.
Showing back view of skipway, grouping of stoves, boiler house, and engine room.

In the case of the modern blowing engine we find the poppet, slide, and piston valves of the steam cylinder replaced by the Corliss. The modern engines are of the vertical cross-compound condensing type, as shown in the photograph which represents the Tod engine built for the National Steel Co. The diameter of the high-pressure cylinder of these engines is 54 inches, that of the low 102 inches, giving a volumetric ratio of 3.57. The air cylinders, which are tandem to and above the steam cylinders, are 108 inches in diameter; the common stroke is 60 inches. At 160-pounds steam pressure and 26-inches vacuum, these engines will develop 5,000 indicated horse power when



ONE OF THE FURNACES OF THE IROQUOIS IRON COMPANY, CHICAGO, SHOWING SKIPWAY.



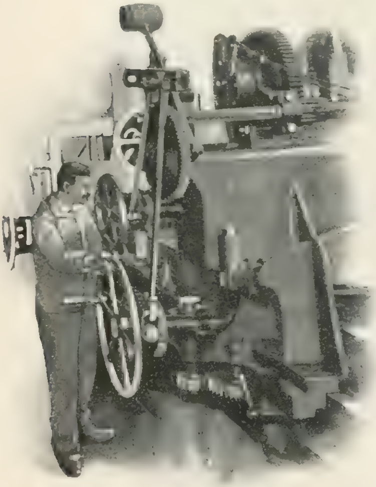
VIEW SHOWING GAS WASHER, GAS BURNER, AND REMOVABLE HOT BLAST VALVES, MASSICK & COOKES' THREE-PASS STOVES, JONES & LAUGHLINS, PITTSBURG.

running at 45 revolutions, and deliver 57,000 cubic feet of free air per minute at 25-pounds pressure per square inch. The weight of these engines is about 635 tons each. In this connection it is to be regretted that the internal-combustion engine, using furnace gases, has not yet found its way into American plants even experimentally. The barbarous practice of developing power by means of the steam boiler continues as the accepted method. From an economic point of view this subject offers a most attractive field, and it is to be hoped that the next epoch in blast-furnace practice will record achievements as successful along these lines as those briefly chronicled in this incomplete *résumé* of modern blast-furnace practice.

NEGLECTED FACTORS IN MACHINE-SHOP ECONOMICS.

By T. S. Bentley.

Mr. Bentley's discussion, like Mr. Longmuir's preceding, is inspired by the rapid increase in the pressure of competition arising from the extension of trade to an international range. But while Mr. Longmuir goes back to the deep-lying sociological causes influencing the quality and capacity of the working class, Mr. Bentley deals directly with matters of management and equipment affecting the quality of the work, but within the immediate province of the employer. The papers supplement one another as propositions for British workshop reform, one treating of the human elements, the other of the mechanical elements in the problem.—The Editors.



AT the present time, when the subject of foreign competition looms so large across the industrial horizon of Great Britain, all points bearing on the comparative cost of production attract universal attention and demand the most careful consideration of British manufacturers.

A number of years spent in close touch with machine shops, and keen observation from points of view both within and without, have convinced me that there are numberless causes of waste and leakage which commonly pass unrecognised, or, where not entirely ignored, are apt to be so grossly under-rated as to be thought of very little account.

There is nothing new about the facts themselves. They are well-known to those connected with machine shops—indeed, it is their very familiarity that frequently leads to their being passed over without a thought. The workmen who are the most directly affected have no power and no special incentive to attempt a remedy, and are not always encouraged to make suggestions regarding affairs which concern the management. The employers, on the other hand, are usually not in a position to gauge with accuracy the effect of these small matters. While there undoubtedly are shops where individual points are noted and remedied, they are merely the "exceptions that prove the rule."

The suitability of the workshop for its special purpose has an effect which cannot easily be overestimated. In many instances this factor alone will practically settle the question of manufacturing success or failure. When a workshop is built with a particular end in view its suitability can be insured, but frequently a building designed for some entirely different purpose is converted into a workshop, in which case—as with all makeshifts—it is uncertain how far the result will be satisfactory.

The lighting in such cases is often woefully deficient, and as a consequence the work suffers both in quantity and quality. No workman can do justice either to himself or his employer if the light by which he works be poor. Artificial illumination is far less satisfactory than daylight, and at the same time adds a considerable amount to the working expenses of the shop. While referring to light it may be well to hint that pounds could often be saved on the gas bill or electric-light account by a trifle more being expended on window cleaning and whitewashing. Much valuable time also is wasted in groping around in a bad light after tools, etc., which should be in full view and ready to hand. The loss due to these few items is not easily realised by anyone who has not worked under such conditions.

The proper heating of the workshop is another point which is usually treated as of but little importance. It is even argued that a cold shop conduces to increased activity and application on the part of the workmen, and is therefore rather an advantage by providing a useful stimulus. No greater fallacy than this was ever uttered. The work in a modern manufacturing shop seldom entails sufficient quick active movement to neutralise the numbing action of a chilly shop filled with ice-cold machinery. The vital heat is therefore sapped from the workmen till the marked disparity of temperature is reduced. Such a shop has a human heating apparatus, which cannot be economical as long as it pays to employ men to hew coal. A shivering man grasps his tools with an uncertain hand and the work he does is scanty and poor. I am convinced that the effect of this during the hours before breakfast is so great that it would often pay to dispense with the "morning quarter" during the winter months.

It is often thought that under the piece-work system these matters merely affect the personal comfort of the workman, and have no place in a strictly economic view. In reality it makes no difference whether the worker is rated by piece or by time. The ultimate standard on which all systems of payment are based is the average output of required quality with the appliances available and under existing conditions of work. The elaborate systems of heating recently introduced into modern factories (notably in America) show that in some quarters the importance of the subject is recognised.

It is a short step from the workshop to its equipment, but it brings us at once to a vital difference in aim and range which divides shops roughly into two classes—the jobbing shop and the factory. In the former both new work and repairs of many kinds and sizes are taken in hand, the various cases being treated individually. Such shops are indispensable under existing circumstances, but are poorly adapted to meet modern manufacturing competition. In their equipment, range and adaptability have been given a foremost place, while to obtain the best results in any given direction these qualities must be sacrificed.

In the class with which we are just now chiefly concerned we have the factory devoted to a particular style of work within fixed limits as to size and kind. It is shops like these that "set the pace" for the world and they can only be equalled by similar concentration. We are proud of British achievements in the industrial world and of the reputation they have earned. If reputation results in diminution of effort, however, it will prove a disastrous legacy. Our foreign competitors are pressing us more closely than ever and we must disencumber ourselves of every hindrance if we are to hold our own in the race. Many of our manufacturing concerns would secure a greater measure of success if they curtailed somewhat the variety of their undertakings and thus concentrated their energies within a narrower compass. It is suggestive to notice how many advertisements, especially in contemporary American trade journals, if stripped of their descriptive technicalities are reduced to the old formula "This one thing I do." Nothing could indicate more clearly how much weight is attached to this point by many of our most formidable rivals. The pronouncement of an expert will always outweigh the opinion of an all-around man, however well informed he may be, and whether the science involved be miltary, legal, or any other. The reasoning that is admitted and acted on in these cases applies with no less force to mechanical subjects, and is equally as true when applied to a combination of experts as to one individual. The fact that it is possible to obtain the highest results in a variety of directions if the concern be of sufficient magnitude in no way affects the main contention. In such cases each department is usually so far distinct that the result is equivalent to a collection of specialised shops financed from a common source. This is exemplified by a number of large "combines" of recent years, in which the factories concerned have frequently been a considerable distance apart and have continued to retain many of their original characteristics.

When the style and range of work has been decided on, the next thing is to select the most efficient plant for producing it. The equipment of a workshop should bear so direct a relationship to the manufacture undertaken as to make the two ideas practically inseparable. Many shops are now engaged in the hopeless attempt to hold their own against keen competition by means of appliances quite unsuited to the needs of the case. Others are striving to keep up with the crowd by the aid of machinery that is obsolete and half worn-out. Such concerns are beaten before they begin. That this state of things exists cannot be gainsaid, and the fact speaks far better for the pluck of those concerned than for their perception or alertness. It is now universally recognised that in the matter of military equipment, to be behindhand and out of date is to court disaster; and the same principle applies with equal force to all industrial questions. To carry the analogy still further, it is never expected that military machinery shall be worn out, but that it must be replaced as soon as improvement threatens to render it obsolete. In a similar way those who in the struggle of manufacturing competition neglect to keep pace with the developments made from time to time in methods and appliances, will inevitably be outstripped by their more enterprising contemporaries. There are notable instances of firms throwing out expensive and almost new machinery in order to adopt a later style, and the results have been in most cases conspicuously advantageous. Naturally the first result of a change of this kind is a seeming loss. This is rapidly repaid by increased output and reduced cost of manufacture, and as soon as the initial outlay is covered the advantage secured becomes pure profit.

In the natural endeavour to secure the best results by the selection of the most suitable plant, discrimination must be used or our object will not be attained. It must ever be borne in mind that the scope of a machine cannot be extended without its efficiency in particular cases being impaired. The converse, however, is equally true, and it must be remembered also that a design calculated to give the maximum result in any one direction is inevitably circumscribed in range. This is a mechanical law from which there is no escape, and to which we incidentally referred when urging that the work undertaken should be kept within reasonably narrow limits as to size, etc. Theoretically, everyone believes in specialised machinery; in practice it is not so universally appreciated. The shop foreman cannot be expected to be enthusiastic over it, as the apportioning of work becomes a matter of far more difficulty if all the machines are to be kept constantly employed. It is probable that this factor accounts in great measure for the abundance of long-gap-bed lathes to be seen in English workshops. Many of them are continually used on short ordinary work so that their adaptability is not required, and it is often forgotten that all their work is handicapped by their structural defects and the valuable shop room that they uselessly occupy. Much is forgiven them, however, for the way they simplify work distribution; but it is a question how far this compensates for the other points mentioned.

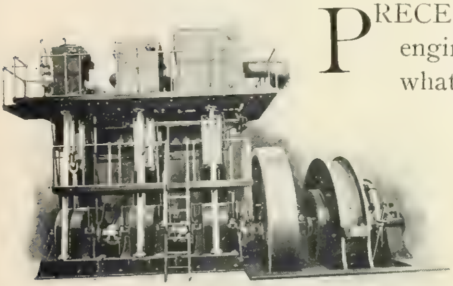
The subject of patterns and designs is one about which much might be said, but I shall briefly touch on one or two points. In any design the first object aimed at undoubtedly should be efficiency, but ease and cheapness of production must never be forgotten. It frequently happens that the draughtsman who works out a design has had no experience of actual shop practice to guide him, and in other cases he is out of touch—if not out of sympathy—with the shop. Unless the designs of such a one are carefully checked by a thoroughly practical man before being finally passed in, difficulty and expense of manufacture may easily be doubled. Sometimes the pattern maker or moulder finds his difficulties increased by reason of some awkward form of doubtful benefit. The machine-shop foreman often has to worry over a needlessly troublesome task; or one perhaps practicable in itself but formidable in the light of the appliances at his command. A plan for the avoidance of this kind of thing has been tried with success in some of the most progressive factories in the United States, in accordance with which the foremen, draughtsmen, and head of departments meet together to discuss the details of any new work that may be coming forward. This not only saves much loss and annoyance due to such little points as have been mentioned, but breeds an *esprit de corps* and general good feeling that goes far to insure the satisfactory accomplishment of any work that may be taken in hand.

The cost of raw material is a point on which many firms keep a vigilant eye, and the matter is frequently intrusted to a buyer chosen for his ability to make good contracts and generally to reduce the amount paid for the various stores required. This plan has its undoubted advantages, but loss is sometimes caused where least suspected. It often happens that a slight difference in the quality of material will add two or three hundred per cent. to the cost of machining and then give a worse result in the matter of finish. On many classes of work the value of the raw material is small compared with that of the labour expended on it. In this way a small initial saving may entail a large ultimate loss.

ENGLISH, AMERICAN, AND CONTINENTAL STEAM ENGINEERING.

By Philip Dawson.

Mr. Dawson's articles began in THE ENGINEERING MAGAZINE for November, 1901, and the two preceding papers have discussed British steam engineering and traction plants. Transposing the order of appearance proposed in our last issue, the section on Continental engines appears below, leaving American steam practice for the concluding paper of the series next month.—THE EDITORS.



PRECEDING articles have dealt with steam-engine practice in Britain. As a preface to what is to be said on the subject of Continental steam engineering, a few remarks on the magnificent show of engines at the Paris Exhibition of 1900 are suitable. It will be remembered that the vast amount of electric energy required for driving exhibited machinery, for lighting the palaces and grounds, and for all the miscellaneous purposes of the Exhibition, was generated in the great power station, the Palais de l'Electricité, in which were collected examples of the latest steam-engine and electric-generator practice of almost all the industrial nations. The United States was not represented on the Champ de Mars, and only by a small installation at the Vincennes Annexe, while from Great Britain also the contribution was a very small one. On the other hand, France, Germany, Italy, Switzerland, and Austria combined to make such a central power station as had never before been seen, containing the best work of the leading manufacturers of these countries.

As regards the power station of the Paris Exhibition, England was but very poorly, and the United States was not at all, represented. The Germans occupied the place that should have been ours. There is no doubt but that as a nation we have a fixed, and in many cases, unreasoning belief in ourselves. This is one of our strong points as a nation because by never being willing to acknowledge ourselves beaten, we often get over difficulties and succeed where others would fail. But this confidence can be pushed to extremes and cause us not to perceive that others are improving whilst we stand still.

Whether the poor show made by Great Britain was due to faulty management or to political or other causes we need not consider here. All foreigners who visited the Exhibition will undoubtedly have gone away with the notion that Great Britain has yielded her supremacy in mechanical and electrical engineering. Such an idea will, of course, be cultivated by all her foreign competitors, and will still further weaken her in foreign markets, where competition is already so severe.

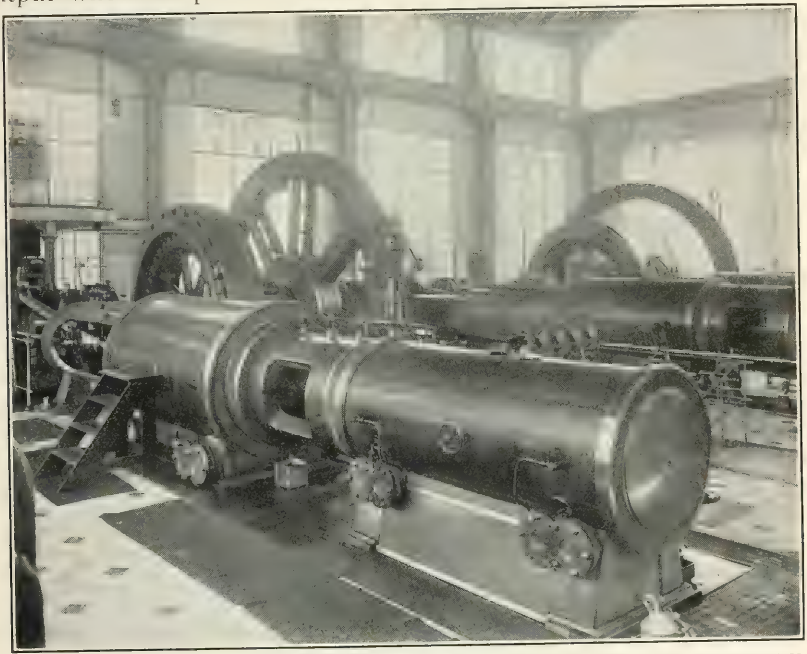
The following remarks upon Continental practice at the present day are based upon the general lines of the engines exhibited at the Paris Exhibition of 1900, and may be taken as fairly representative.

Taking the horizontal engines first, as being more common than the vertical type, it is almost the invariable practice to use trunk beds. The cylinders, although to a certain extent overhung, are rarely entirely so; in fact, they are usually supported at each end by pedestals which form part of the steam chests. In most cases the main plummer block forms part of the bed plate, but in the Dujardin engine and some others it is secured by a faced and bolted joint. The guides for the cross-head are nearly always bored out in circular form. The plummer blocks are generally extremely massive, with cast-iron babbitt-lined steps, but the shafts would seem to be rather on the small side. With regard to cranks, French makers seem to favour crank discs made of cast iron, but otherwise wrought-iron or steel crank arms with heavy balance weights seem to be the usual practice.

In tandem engines the connection between the cylinders usually consists of a large hollow casting. Most of the large engines have the cylinder covers steam-jacketted, and almost all are fitted with vertical air pumps below the ground level. The flywheels as a whole seem to be rather light, and not much attention appears to have been devoted to this point, whilst the construction varies considerably. With regard to cross-head, it is scarcely possible, in view of the numberless varieties which appear to exist, to fix upon any special form and call it standard. Most tandem engines employ some sort of bearing between the cylinders to support the piston rod and prevent wear of the glands. In the big ends of the connecting rods the most usual practice is either the wedge-adjusted solid end or the marine pattern.

With regard to valve gears, there are a very large number of varieties. The Collmann gear is very popular. The type of valve which is characteristic of Continental practice is the "poppet" valve. A trip gear of some sort is practically universal.

Dynamo-electric machinery is of much more uniform type of construction than used to be the case some years ago. Nearly all alternating or polyphase machines have fixed armatures and revolving field magnets, the latter in many cases taking the place of a flywheel. A number of the large polyphase machines seem very heavy for their output when compared with standard American practice. In some German machines lightness has been pushed to extremes, and in one case tie rods had to be added afterwards.

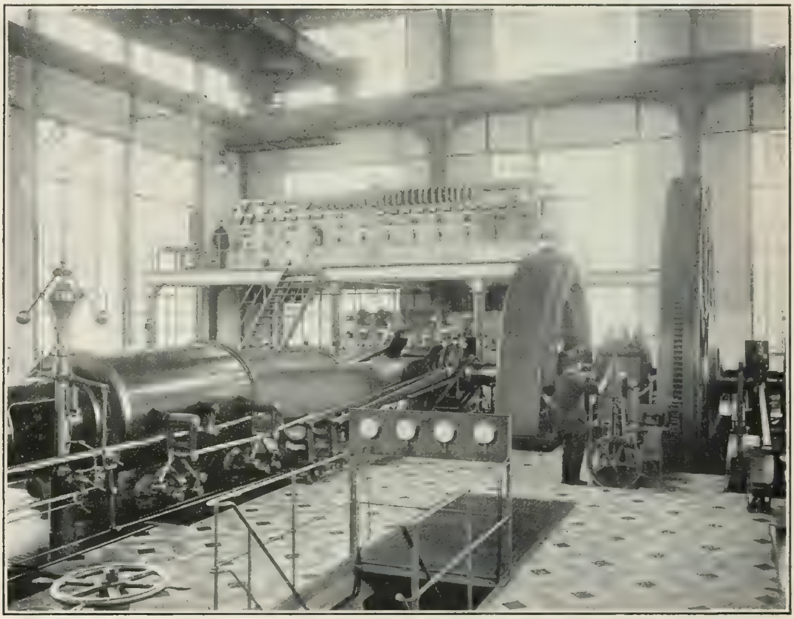


1500-HORSE-POWER FOUR-CYLINDER HORIZONTAL DOUBLE TANDEM ENGINES BY DUJARDIN OF LILLE.

Installed by the French Thomson-Houston Company.

In most of the continuous-current machines slotted armatures are used. The conductors which connect one commutator bar to the other are generally composed of separate strips soldered together. This method has been given up in America in favour of coils forged out of one piece of copper and having soldered joints only at the commutator. The general practice, as shown at the recent Exhibition, is to drive the exciters directly off the main shaft of the main engine. For large units it would seem preferable to have separate exciting sets, so that anything going wrong with the exciter would not lay up a main generator. Furthermore, small machines, such as exciters, can satisfactorily run at much higher speed than the large main generators.

The method of rating the capacity of generators and steam engines seems to differ from what has been found to be advisable for traction and power purposes where sudden overloads are frequent. The rated capacity is generally the maximum load which a generator can safely carry for several hours. The better way is to have the rated load the one at which the machine runs with the greatest economy, building the engine and dynamo, however, in such a way that they can, for at least two hours continuously, carry from 25 to 50 per cent. overload without injury, and can momentarily carry from 50 to 100 per cent. overload. It is probably owing to the different method of rating and to the difficulty which many European manufacturers have found in building dynamos which will come up to the above specifications, that storage batteries are used so extensively on the Continent. In this connection a card hung on one of the large continuous-current dynamos stated that one of the great merits of this machine is that it could stand 20 per cent. overload for short periods. This is particularly remarkable, as in all traction specifications which have been issued by competent engineers in Great Britain it is specially stated that the generator shall, for at least two hours, stand overloads vary-



DUJARDIN ENGINES, ORLÉANS POWER STATION.

Installed by the French Thomson-Houston Company. Four-cylinder horizontal double tandem type. 1,500 horse power.

ing from 25 to 50 per cent. without the development of injurious heating or sparking.

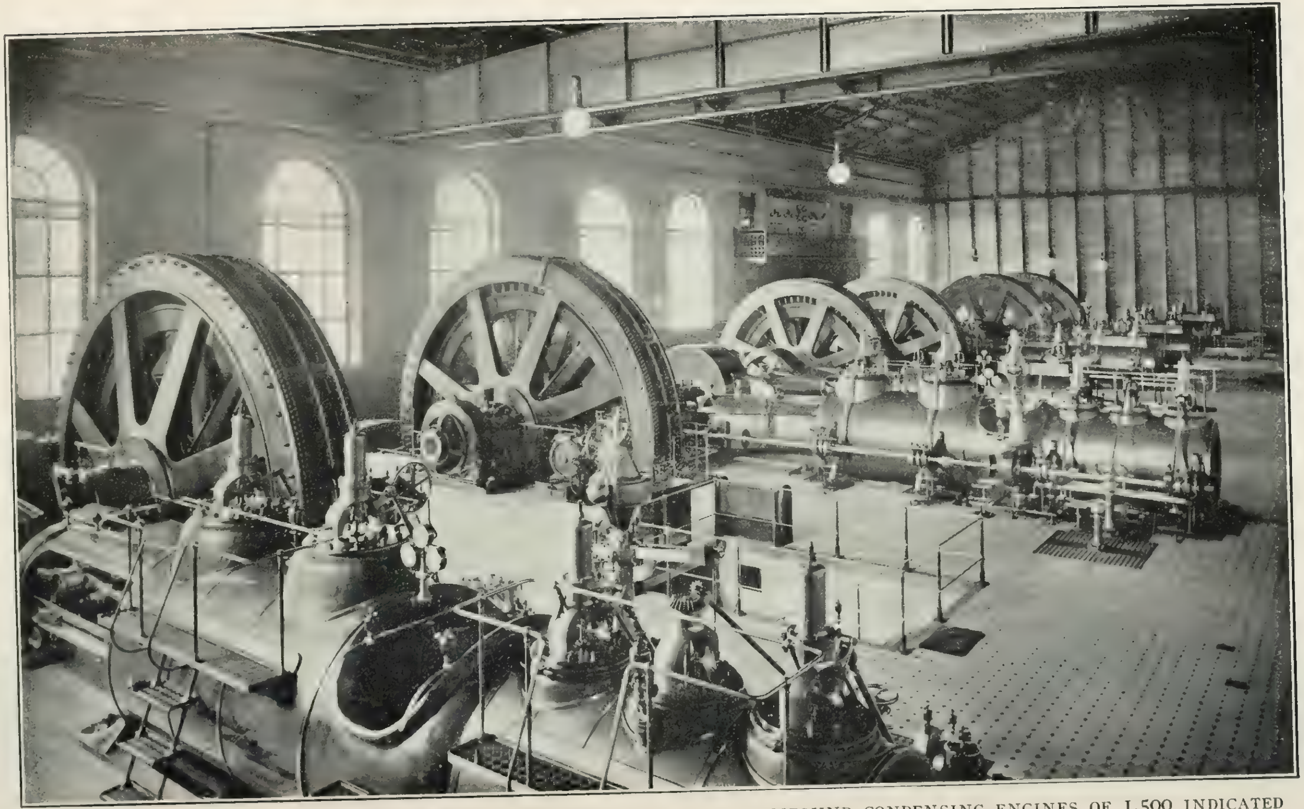
As regards the engines and generators shown in the British section, they were externally not so carefully finished as their foreign neighbours. Many similar engines running in British central stations present a much better external appearance than those shown in the Palais de l'Electricité. This was a pity, and was presumably due to the engines not having been ready in time and having to be rushed through.

Paris Metropolitan Railway; Electric-Power Station. The power station is located at Bercy on the Quai de la Rapée, situated on the bank of the Seine, near the Paris, Lyons, and Mediterranean Railway terminus. As well as furnishing continuous current to the lines, the station is designed to supply three-phase high-tension currents to a sub-station installed under the Place de l'Etoile between the Avenues Hoche and Wagram.

The steam-generating plant consists of thirty-six boilers arranged in three groups of six pairs each. These boilers are of the elephant type, consisting of two horizontal cylindrical bodies joined by three short tubular legs to the upper main cylindrical portion, which is also horizontal, and contains fire tubes. The lower cylinders have a diameter of about 3 feet, that of the upper one being 7 feet 2½ inches. The heating surface of each boiler is 2,626 square feet.

In the engine room there are four 1,500 kilowatt direct-coupled units, the engine being of the two-cylinder cross-compound vertical type, with the generator mounted on the shaft between the cylinders. Both cylinders are provided with four Corliss valves, the cut-off in the high-pressure being regulated by the governor; a special safety governor acts on two balanced slide valves on the high-pressure and low-pressure cylinders. Each cylinder is jacketted with live steam, and there is a reheating receiver.

The cylinders measure 41.34 inches and 70.87 inches by 59.05 inches stroke; the piston rods are 6.67 inches diameter, and the crank pins 13.39 inches diameter. The length of the connecting rod is 11 feet 6 inches. The diameter of the crank shaft in its bearings is 19.29 inches and the length of the bearings is 39.37 inches. There are three main bearings, one at each end, and an intermediate one in the middle of the shaft between the generator and flywheel. The engines were constructed by Messrs. Schneider & Co., and indicate 2,500 horse power when running at 70 revolutions per minute under normal conditions. Continuous automatic lubrication is supplied.



FRANKFORT CORPORATION ELECTRICITY WORKS. FOUR SULZER TANDEM-COMPOUND CONDENSING ENGINES OF 1,500 INDICATED HORSE POWER EACH AND FOUR OF 750 HORSE POWER EACH. ELECTRICAL MACHINERY BY BROWN, BOVERI & CO.

Orléans Railway Extension; Electric-Power Station. The power station is built at Ivry, about three miles from the Quai D'Orsay terminus, and generates high-tension three-phase current; the whole of this plant is by the French Thomson-Houston company.

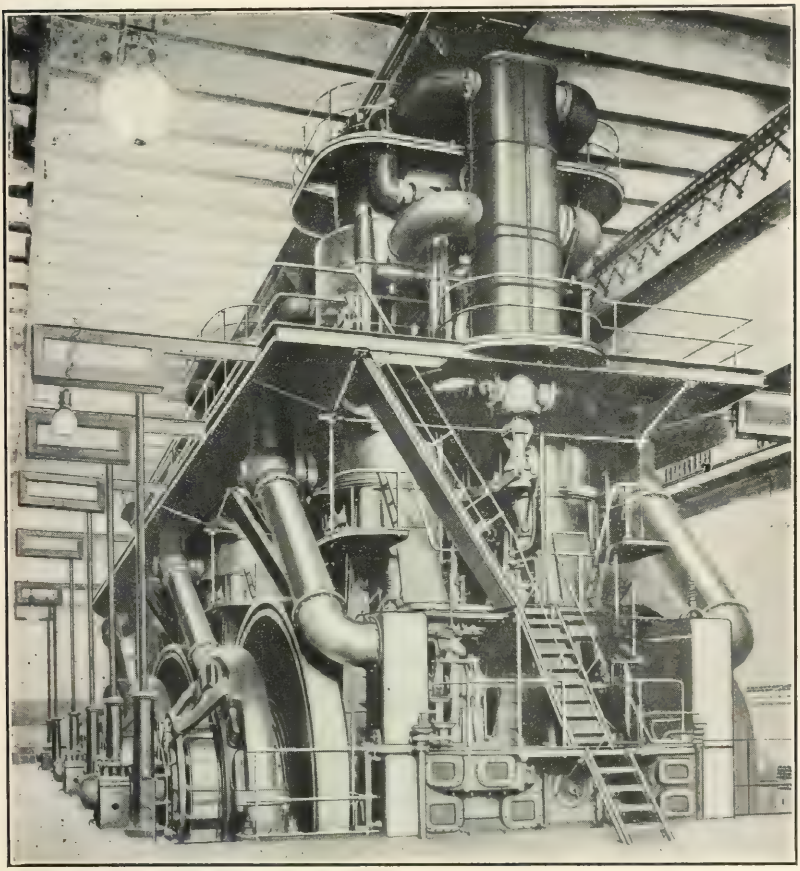
The boiler room contains eight Babcock & Wilcox boilers, arranged in two groups. The heating surface of each boiler is 2,002 square feet; the drums are 3 feet 11 inches in diameter by 23 feet long, and there are ninety tubes 18 feet long and 4 inches diameter. The grate area is 36½ square feet and steam is delivered at a pressure of 185 pounds per square inch. These boilers supply steam to two horizontal triple-expansion four-cylinder Corliss engines, running at 75 revolutions per minute, and giving 1,200 to 1,500 horse power each. There is one high-pressure cylinder 24 inches diameter, one intermediate-pressure cylinder 36¼ inches diameter, and two low-pressure cylinders $41\frac{5}{16}$ inches diameter, and the length of stroke is 65 inches. Steam distribution is effected in each cylinder by four rotary Corliss valves, the cut-off in the high-pressure cylinder being controlled by the governor. All the cylinders are steam-jacketted. The shaft is carried in three bearings, one at each end forming part of the engine frames, and one in the centre of the shaft between the fly-wheel and dynamo. The fly-wheel is 24 feet 7 inches in diameter and is keyed onto the shaft. The builders of the engines are Messrs. Dujardin of Lille. The exhaust steam is dealt with by vertical jet condensers. The air and water are exhausted by two vertical single-acting pumps, driven off the head of the low-pressure connecting rod.

General steam-engine practice is much the same the Continent over. As regards outside appearance, many more parts are polished bright, and in some cases nickel-plated, than is usual in England and all parts are more highly finished. England itself in that respect is much more careful than the United States, and much rougher finish is tolerated there than in Europe. Tandem engines are nearly always used, and triple-expansion even for traction work are generally adopted. In Germany, tandem engines are even put in in the case of vertical engines, or have been till quite recently. When these are not employed the marine type of vertical engine is much liked.

To illustrate this tendency I cannot do better than describe and illustrate the Berlin plants of the "Berliner Elektricitäts Werke" put in by the Allgemeine Elektricitäts Gesellschaft, of Berlin, and the Hamburg works put in by Schuckert Co., of Nürnberg, and the Frankfort station put in by Sulzer and Brown, Boveri & Co. The Berlin

Name of Station.	Year started.	Total capacity at start in Kilowatts.	Total capacity in kilowatts of station in 1900.	Total number and type of boilers, 1899.	Type, number and capacity in indicated horse-power of each steam engine.	How connected to dynamos	Number, type, and capacity of generators.	Remarks.
Markgrafenstrasse	1885	500	3,028	Nine Heine	Six 500 I. H. P. Corliss compound condensing, 82 revs.	Direct.	Six 238 kilowatts, continuous current; three 400 kilowatts, continuous current.	Driven by 3 three-phase motors supplied with power from Schiffbauerdamm.
Mauerstrasse, . .	1886	247½	5,988	Ten Steinmüller.	Two 300 I. H. P. Corliss compound condensing, 82 revs.; four 1,000 I. H. P. Corliss compound condensing, 75 revs.; two 1,500 I. H. P Sulzer compound condensing Bon Jour Corliss. 10 revs.	Direct.	Two 238 kilowatts, continuous current; eight 364 kilowats, continucus current; four 650 kilowatts, continuous current.	Battery of accumulators, 250 volts working pressure, and 6 000 ampere hours in parallel
Spandauerstrasse .	1889	1,456	7,384	Eight Steinmüller, eight Heine.	Three 1 000 I. H. P. Corliss compound condensing, 70 revs.; one 1,500 I. P. H. Corliss compound condensing, 70 revs.; three 1 500 I.H.P. Sulzer compound condensing, 105 revs.	Direct.	Six 364 kilowatts, continuous current; two 650 kilowatts, continuous current; six 650 kilowatts, continuous current.	Battery of accumulators, 250 volts, working pressure, 6,000 ampere hours in parallel.
Schiffbauerdamm .	1890	728	4,984	Eleven Steinmüller.	Three 1,000 I.H.P. Corliss compound condensing, 70 revs.; two 1,500 I.H.P. Collmann compound condensing, 105 revs.	Direct.	Six 364 kilowatts, continuous current; four 700 kilowatts, three-phase.	Transmits power to Markgrafenstrasse.
Luisenstrasse . .	1899	2,000	6,000	—	Three triple-expansion vertical condensing, Sulzer 85 revs.	Direct.	Six 1,000 kilowatts, 250 volts, shunt-wound continuous current.	—
Oberspree		10,36	10,368	Chiefly Heine.	Two Horizontal Görlitz, 1,000 I.H.P. Two Vertical Görlitz, 2,000 I.H.P. Two Horizontal Görlitz, 4.000 I.H.P	Direct.	Four 364 kilowatts, three phase. Four 728 kilowatts, three-phase. Four 3000 kilowatts, three-phase.	Transmits three-phase current at 6000 volts.
Moabit		9,000	9,000	**Heine.**	Three Horizontal, Sulzer 4,000 H.P.	Direct.	Three 3,000 kilowatts, three-phase, generators at 1000 volts.	

TABLE SHOWING THE EQUIPMENT OF BERLIN'S LARGE COMBINED LIGHT AND POWER STATIONS.



LUISENSTRASSE CENTRAL ELECTRIC STATION, BERLIN.

Four-cylinder vertical tandem triple-expansion Sulzer engines, 3,300 horse power. Installed by the Allgemeine Elektricitäts Gesellschaft.

Electricity Works is a separate company which controls the supply of electric power for all purposes in Berlin.

The tables on pages 526 and 528 embody data of some of the most interesting plants of the Berlin Electricity Works. These stations date back some fifteen years, and the last of the series is not yet quite completed. They supply Berlin with light and motive power, and also run the electric tramways, which are rapidly superseding horse and other methods of traction in that city.

The upper table on page 528 gives some idea of the rapid growth of the demand, and there seems to be no reason to doubt that this will steadily increase for the next few years in the same ratio.

The concession for the Berlin enterprise was given in 1884. The

GROWTH OF OUTPUT OF BERLIN ELECTRICITY WORKS.

Output in Kilowatt-hours.

—	Private Lighting.	Street Lighting.	Motors.	Traction.	Total.
	kw.-hrs.	kw.-hrs.	kw.-hrs.	kw.-hrs.	kw.-hrs.
1890	2,441,000	292,000	69,000	—	2,802,000
1891	3,455,000	294,000	274,000	—	4,023,000
1892	4,696,000	293,000	186,600	—	5,175,000
1893	5,179,000	291,000	238,000	—	5,708,000
1894	5,369,000	336,000	570,000	—	6,275,000
1895	5,907,000	359,000	1,071,000	—	7,337,000
1896	6,909,000	385,000	2,220,000	257,000	9,771,000
1897	8,094,000	408,000	4,009,000	1,758,000	14,269,000
1898	9,315,000	425,000	5,833,000	2,443,000	18,016,000
1899	10,143,000	485,000	7,759,000	10,167,000	28,554,000
1900	11,202,000	882,000	17,240,000	20,170,000	49,494,000

DATA OF SOME OF THE DIRECT-CONNECTED COMPOUND CONDENSING STEAM ENGINES IN THE BERLIN CENTRAL STATIONS.

——	VAN DEN KERCHOVE.			Görlitzer Maschinenbau Anstalt.	Sulzer Frères.	Sulzer Frères.
	Corliss Gear.	Ghent Gear.	Bonjour Gear.			
Rated power in indicated horse-power	300	1000	1500	1500	1500	3000*
Diam. of high-pres. cylinder in milli...	482½	736½	800	930	875	high pres., 865 inter. " 1250
Diam. of low-pres. cylinder in milli...	863½	1320	1450	1450	1300	1550 1550
Stroke in milli.	762	1447	1100	1100	1200	1300
Revolutions per min .	80-85	60–75	105-110	105-110	105-110	85
Diam. of outboard bearing in milli...	275	343	300	400	300	—
Length of outboard bearing in milli....	610	508	600	800	580	—
Diam. of inboard bearing in milli....	275	343	365	400	380	—
Length of inboard bearing in milli....	610	432	430 & 510	600	540 & 710	—
Length of shaft in milli	3950	10,900	10,150	13,000	11,000	—
Diam. of crankpin in milli	204	305	305	400	400	—
Length of crankpin in milli	248	292	290	370	350	—
Steam pres. in lbs. per sq. in. at throttle ..	130	130	130	130	130	175
Steam cons'p'n in lbs. per indicated h.p. h.	17.6	15.9	13.5	13.8	13.8	11½

* Triple-compound condensers using superheated steam.

first power station was put into operation in 1886. At the present there are six power stations in operation or under construction, as follows:—

Schiffbauerdamm-Luisenstrasse	21,100	horse power.
Spandauerstrasse-Rathausstrasse	14,600	"
Mauerstrasse	14,500	"
Markgrafenstrasse	2,100	"
Oberspree	54,000	"
Moabit	36,000	"
Total	142,300	horse power.

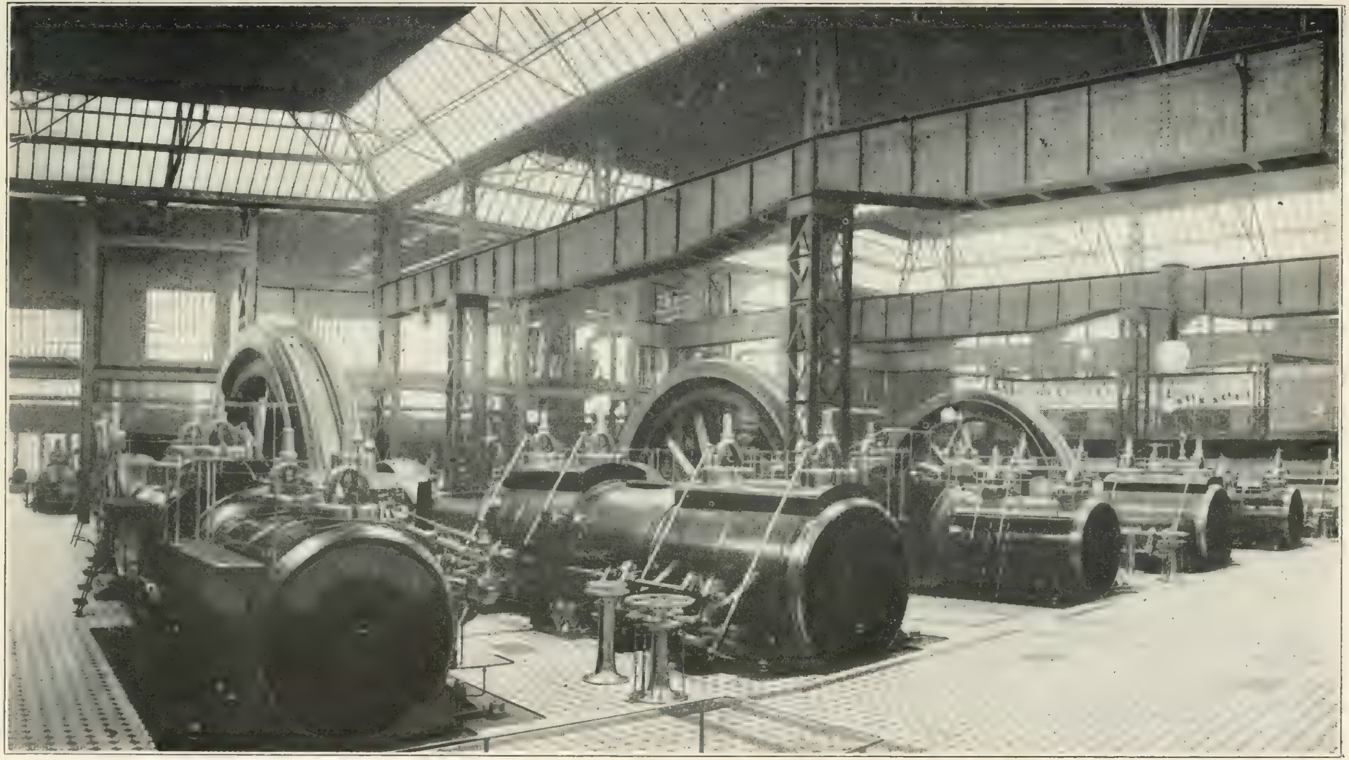
The total engine power actually under operation amounts to 90,000 horse power.

From 1885 to 1886 cross-compound vertical engines having a belt drive between the two cylinders were used. The valve gear was piston type. The cylinders were 360 and 580 millimetres diameter, stroke 360 millimetres, and 210 revolutions per minute. In 1888 to 1890 two-cylinder-tandem vertical Corliss engines were purchased from Van den Kerchove; cylinders were 482½ and 863½ millimetres in diameter with a stroke of 762 millimetres and running at 80 to 85 revolutions per minute, each direct-connected to one generator. In 1889 to 1893 cross-compound verticals of the same make were installed, the two cylinders being side-by-side with a generator at either end of the shaft. The cylinder diameters were 736½ and 1,320 millimetres, 1,447 millimetres stroke, and 60 to 75 revolutions per minute. A similar type by the same makers was installed in 1895 to 1897 with "Bonjour" valve gear, but otherwise similar to the previous type. Dimensions were 800 millimetres and 1,450 millimetres cylinder diameter, 1,100 millimetres stroke, 105 to 110 revolutions per minute. Sulzer Brothers of Winterthur in 1896-97, furnished similar vertical engines with Sulzer poppet valves, 875 and 1,300 millimetres cylinders and 1,200 millimetres stroke, 105 to 110 revolutions. The Görlitzer Maschinenfabrik also in 1896-97 put in the same type but with "Collmanns" valve gear. Cylinders were 930 and 1,450 millimetres, stroke 1,100 millimetres, and 105 to 110 revolutions per minute.

A larger and novel type of steeple-tandem triple-expansion engine was introduced in 1899. There is one high-pressure cylinder 865 millimetres, one intermediate 1,250 millimetres diameter, and two low-pressure cylinders each 1,550 millimetres. The stroke is 1,300 millimetres and the speed 83 revolutions per minute. The high-pressure and intermediate cylinders are each above one low-pressure cylinder. The engine itself has four bearings, and there is an out-board bearing on each side of the machine to support the generators, of which there are two, one on each end of the shaft. The steam pressure at the stop valve is 12 kilogrammes per square centimetre at a temperature of 300 degrees centigrade. All cylinders, with exception of the high-pressure, are steam jacketted. As is usually the practice in Germany and Switzerland, only the back part of the frame carrying the slide on which the cross-head works is a casting, the front part of the engine being supported by polished steel columns. In all the engines mentioned above the condensers are worked directly by the main engine. This practice reduces the amount of power required by the condenser but has the disadvantage that should the engine be overloaded the condenser cannot be forced, and also should anything go wrong with the condenser the whole engine would probably have to be shut down. As is now generally the practice in all countries, the bearings are spherical and self-adjusting. The construction, finish, and general working of these engines is beautiful, but unfortunately the valve gear and the transmission of movement is of the most complicated nature. Any repair or examination of the low-pressure pistons is most difficult, and in some cases entails taking down most of the engine. Supervision, owing to the great height of these engines from the ground, is also arduous and expensive.

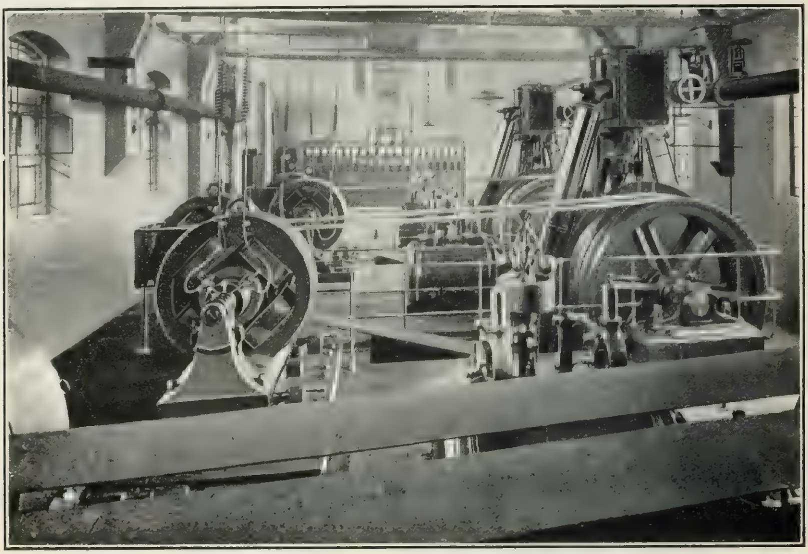
The remarkable result has been that, contrary to British or American practice, the engineers of the Allgemeine Elektricitäts-Gesellschaft, for all powers above 1,000 horse power, now install horizontal engines. The drawbacks of such large sizes are overcome by supporting nearly the total weight of the pistons and piston rods on a bearing between the two cylinders, in the case of tandem engines, or of building large bridgework projections at the back carrying a sort of auxiliary cross-head, which, with the main crosshead, carries the weight of the piston and piston rod.

In comparing the stations which have recently been installed in Berlin it will be found that American practice has been largely followed in their layout and construction. Berlin is more fortunate than London from the consumers' and suppliers' point of view, as it is there possible to concentrate the supply of electrical power for all purposes in the hands of one large company, who thereby are permitted to put up very large stations and to spend money freely so as to reduce the cost of production. If this had been possible in London similar results would no doubt have been obtained.



OBERSPREE STATION, BERLIN ELEKTRICITÄTS-WERKE. MACHINERY PUT IN BY THE ALLGEMEINE ELEKTRICITÄTS GESELLSCHAFT.

A careful study of the present situation should convince anyone that England is behind other nations, certainly from a manufacturing standpoint. The reverse ought to be the case.



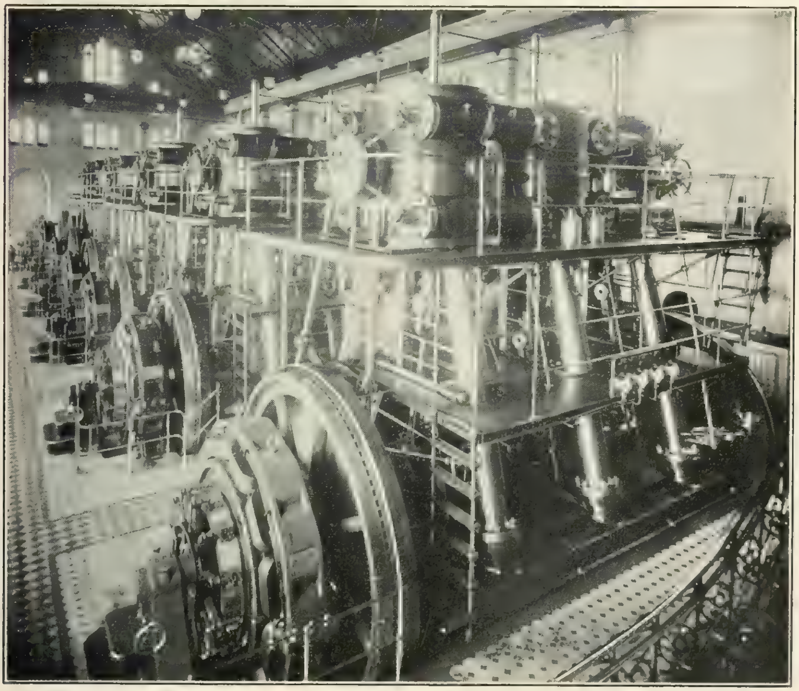
ELECTRIC TRAMWAY POWER STATION, BERLIN.

Showing combined vertical and horizontal engines, installed 1891, similar in type to the engines now being put in by the Manhattan Elevated Railway, New York.

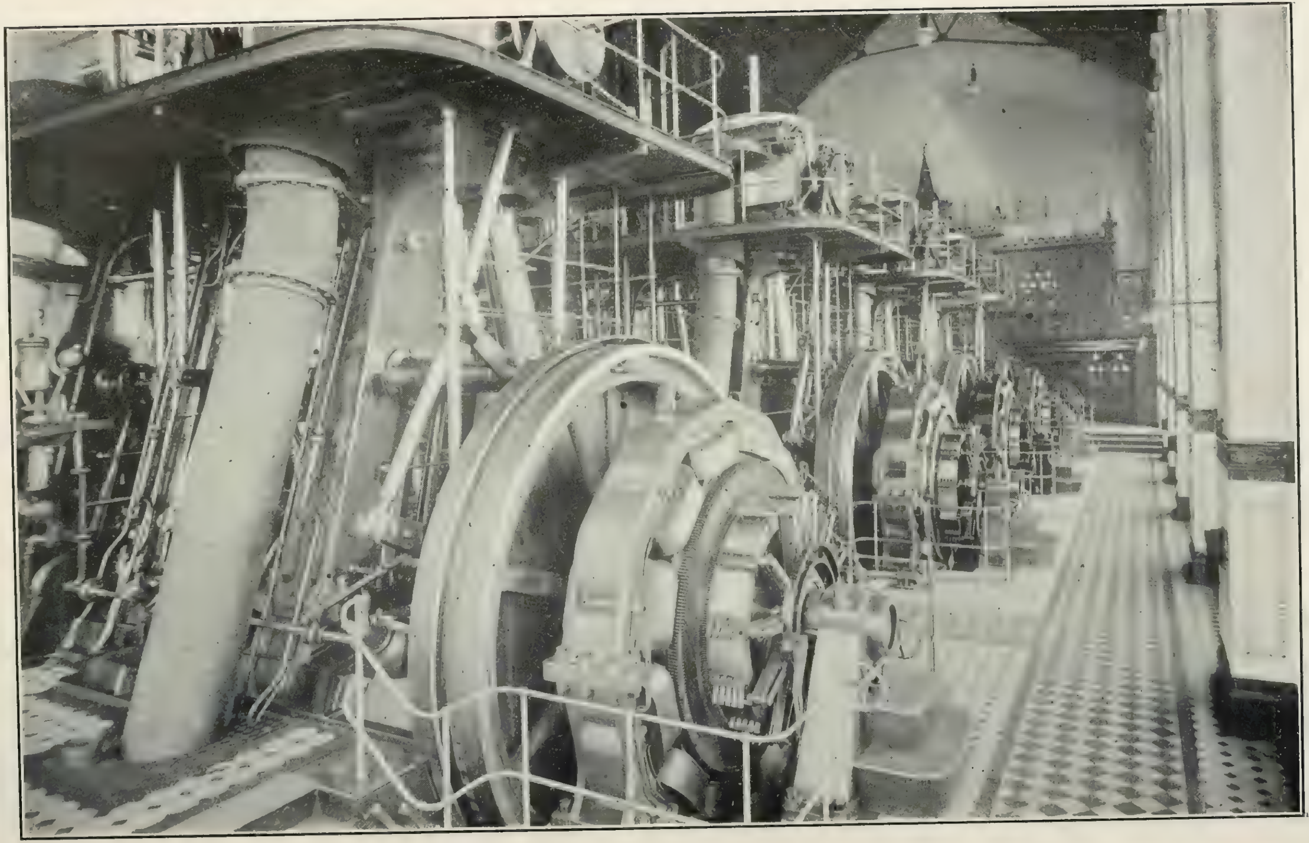
There is little doubt that, notwithstanding the relatively poor show made at Paris, British steam engines are in their essential parts, and in working, at least equal to those of any foreign manufacturer. We should, however, not disdain the fine finish and the great attention to even the smallest detail which is the characteristic feature of foreign-built engines. All engineers know the good work turned out by the three great British engine builders who exhibited, but as far as outward appearances go they are distinctly at a disadvantage among their highly-finished foreign neighbours.

Unfortunately even this cannot be said as regards electrical machinery, as a glance at the foreign exhibits and the British soon proved. Some of the causes for this are very well set forth in a leading article in the *Times* of April the 19th, 1900, which served as an introduction to the excellent series of articles on "American Engineering Competition" that have appeared in its columns. The *Times* calls attention to our "countrymen's want of knowledge and the indifference of British manufacturers to the very real danger which menace their industrial position. Very few Englishmen go to the United States for observation and instruction as Americans constantly visit Europe. It is difficult without personal enquiry to realise the competition that is preparing for us."

The electric power plant at Hamburg is a combined lighting and traction station, and has been considerably enlarged since it was originally laid down. The entire equipment was carried out by Messrs. Schuckert & Co. The electric-generating plant consists of seven direct-coupled steam dynamos. The engines are of the triple-expansion condensing vertical marine type; at 100 revolutions per minute and 147 pounds steam pressure, each engine develops 1,000 to 1,200 brake horse power. The height of the engine is about 24 feet 6 inches and it occupies a floor space of 26 feet 3 inches by 14 feet 9 inches, approximately. The high, intermediate, and low-pressure cylinders are placed side-by-side, the cranks being arranged 120 degrees apart. There are two flywheels to each engine, measuring about 13 feet in diameter and weighing 7½ tons each. Steam distribution is effected by Corliss valve gear, and the governor controls the cut off in both the high and intermediate-pressure cylinders. For lubrication an oil tank is placed on the top of each engine; after passing through the bearings, the oil is collected in another tank situated

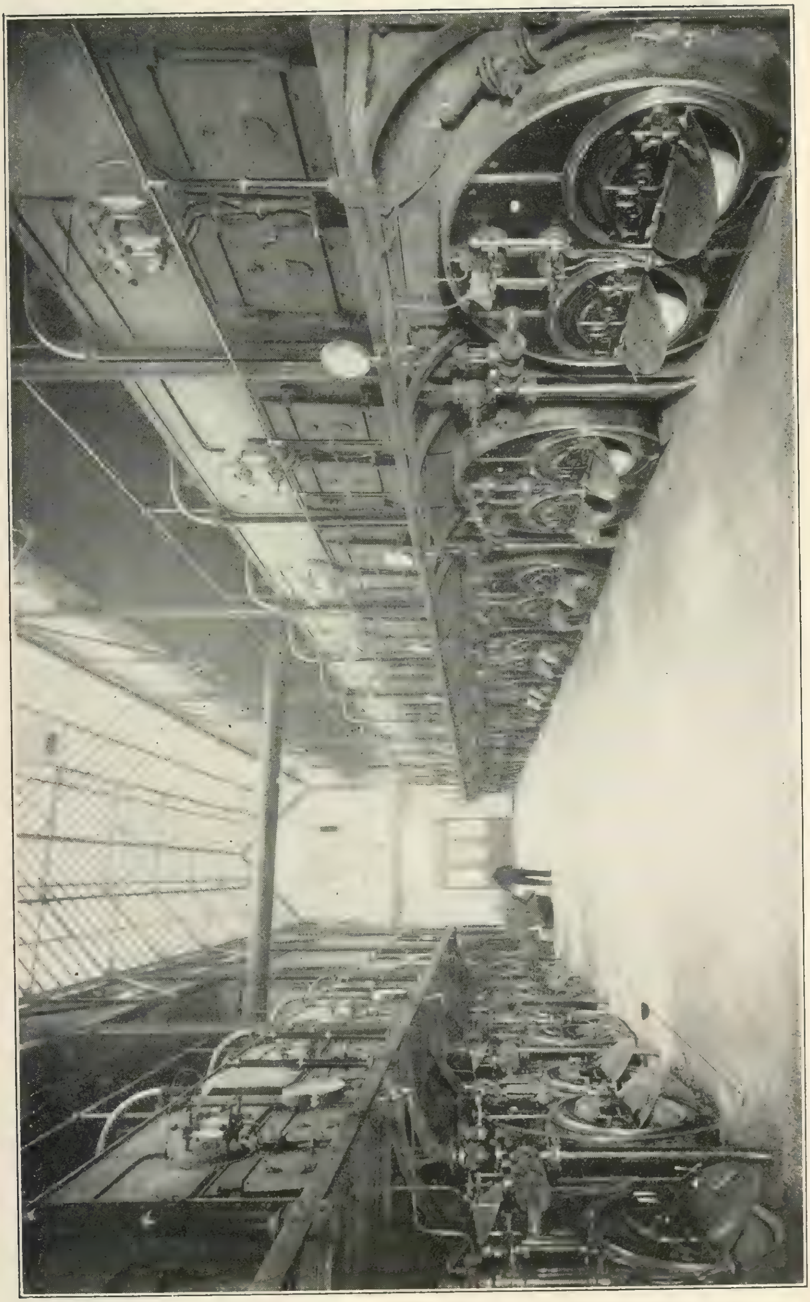


A GENERAL VIEW OF THE HAMBURG POWER-HOUSE ENGINE ROOM.



ENGINE ROOM OF THE HAMBURG POWER HOUSE.

Eight 400-kilowatt vertical triple-expansion Khun engines, Schuckert dynamos.



BOILER HOUSE OF THE HAMBURG CENTRAL-STATION POWER PLANT.

underneath the bed plate, from which, after being filtered, it is pumped up to the upper tank. All the cylinders are steam-jacketted, the high and intermediate-pressure cylinders with boiler steam, and the low-pressure cylinder with steam from the intermediate receiver. The cylinders measure 22.64 inches, 36.41 inches, and 53.15 inches, by 39.37 inches stroke. Each engine is coupled direct to two dynamos, one on each end of the shaft.

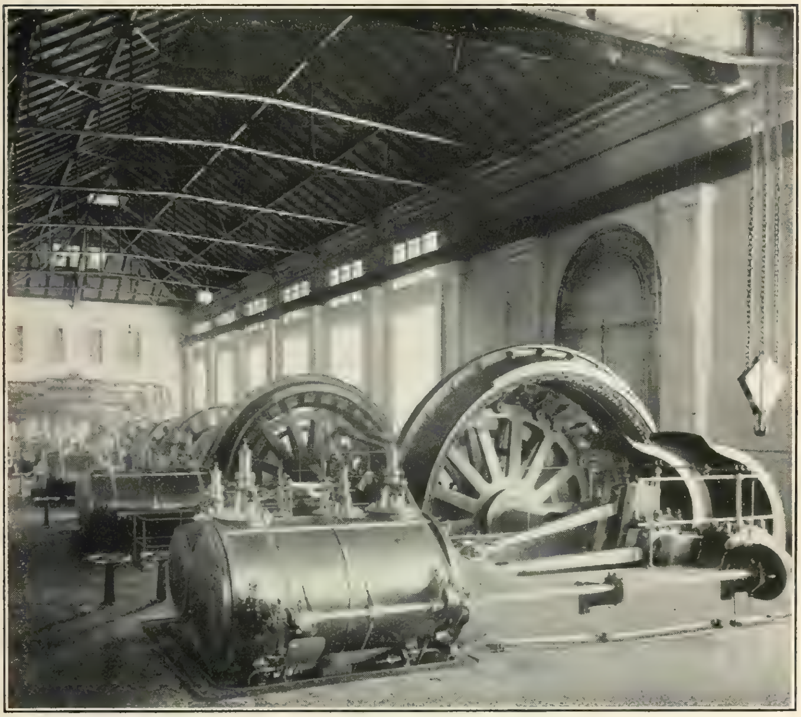
The boilers employed in this station are of the composite type so much used on the Continent, and consist, to all intents and purposes, of a marine-type "dry-back" superimposed upon a Galloway boiler. The upper boiler contains 125 fire tubes, each 3.74 inches in diameter; the lower boiler has a length of 19 feet 3 inches and a diameter of about 8 feet. Each boiler has a heating surface of 2,691 square feet. The furnaces are hand-fired.

It is not only Germany, France and Belgium which must be taken into consideration; Italy with the well known and successful firm of Franco Tosi of Legnano must not be overlooked. A short typical description of the engines built by this firm will, it is thought, prove of interest. The following gives a general idea of the standard practice of the Franco Tosi Co.

The cylinders are jacketted, the jacket being formed of a liner. The heads are also jacketted. There are four valves to each cylinder, the steam valves on top and the exhaust valves below. The piston is made in one piece, cast hollow and ribbed, giving strength without weight. The piston rings are made of cast iron.

The tandem and triple-expansions type of engines have box-girder frames with bored cross-head slides cast in one piece with the main crank-shaft bearing. The cross-compound engines are usually built as centre-crank engines, to admit of coupling on a generator each side. The frame consists of two symmetrical pieces, one right and the other left-hand, each frame containing a guide, one outer bearing, and half of the middle bearing. A flat one-sided guide is used.

The cranks and crank-shaft are of hammered steel with the cranks shrunk on. A high-speed Porter governor is employed. Poppet valves are mostly used, but in some a slide valve is used (generally either with single-cylinder or tandem-compound engines) with Rider cut-off controlled by Porter governor. In tandem engines the practice is to connect the low-pressure to the frame and place the high-pressure cylinder behind it. For triple-expansion, with three cylinders, the practice is to connect the high and medium-pressure engines tandem (medium-pressure in front) and the low-pressure cylinder parallel



FRANCO TOSI HORIZONTAL CROSS-COMPOUND ENGINES AND OERLIKON GENERATORS, GENOA CENTRAL STATION.

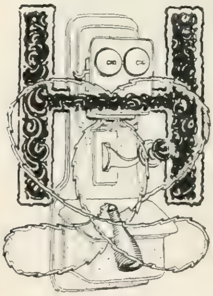
with them, the two cranks being at 90 degrees. With four-cylinder triple-expansion, it is usual to place one low-pressure cylinder tandem with the high-pressure cylinder, and the other tandem with the medium-pressure cylinder, the low-pressure cylinders being in front in each case, and the cranks at right angles. Franco Tosi also built a vertical high-speed type of engine, in sizes from 25 to 400 horse power. In these engines the steam distribution is effected by piston valves, with variable cut off controlled by a shaft governor.

With this necessarily brief review I must leave the subject of Continental steam-engine practice. My fourth and concluding paper will treat of the work done in this department of engineering in the United States.

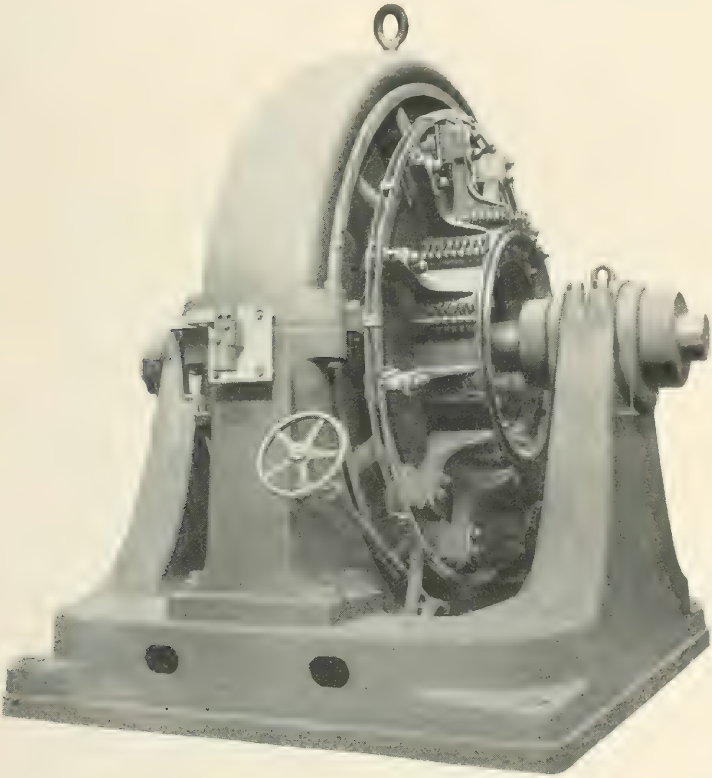
THE OPERATION OF THE ROTARY CONVERTER.

By David B. Rushmore.

Mr. Rushmore's preceding article, in our December issue, was concerned chiefly with the design and construction of the rotary converter. In the following pages he discusses its practical use and the phenomena of its operation.—The Editors.



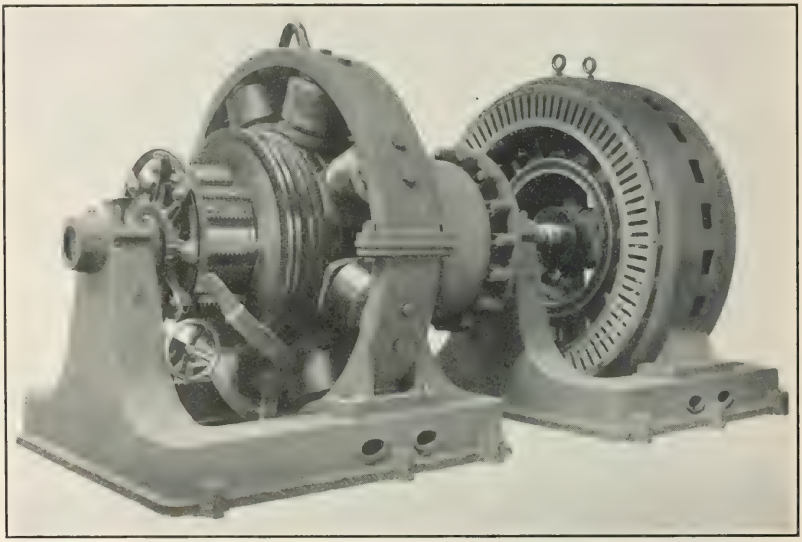
HUNTING, as the phenomenon is usually designated, is an electrical and mechanical oscillation due to a variety of causes, which, in various degrees, is of frequent occurrence in the operation of alternating-current machinery. In practice it is often met in the parallel running of alternators or in the operation of synchronous motors. As regards its operating conditions, a converter may be regarded as a synchronous motor except that, as no mechanical power is taken off, the converter is the more susceptible of the two to the influence of slight irregularities in the conditions of electrical supply. One of the common causes of hunting is a variation in the angular velocity of the prime mover. This may be due primarily to faulty engine design, such as a short connecting rod, a governor which is too sensitive, or lack of sufficient flywheel capacity. The phase relations of current and electromotive force in the synchronous motor are extremely sensitive. If a sudden load comes on the motor, or if the frequency of the supplied current is slightly increased by the increasing angular velocity of the engine at that instant, the current of the motor increases and the position of the armature with respect to the field may become more favorable, so that there is a strong force brought into action to increase the speed of the motor. Now, as the revolving part of the motor possesses weight, it takes an appreciable time for this to occur; and the probability is that the strength of the synchronizing impulse has been more than sufficient to raise the revolving part to the frequency which



1,500 KILOWATT THREE-PHASE ROTARY CONVERTER FOR MANHATTAN ELEVATED RAILWAY, N. Y.

One of twenty-six built for the new power house by the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa. They are the largest rotaries yet constructed.

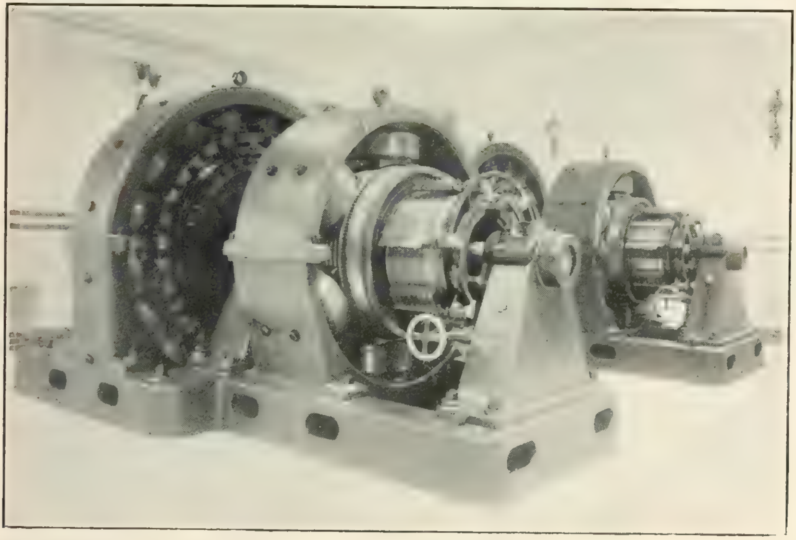
existed at the time of the impulse, and the rotor will be sent ahead of synchronous position. If now, as the rotor increases in speed, the engine reaches a part of its cycle where the angular velocity is decreasing, and with it the frequency of current, the tendency will be to throw the motor ahead and out of step. The same result will accrue in the opposite direction at the other half of the engine cycle. In this manner the motor is sometimes ahead of and sometimes behind the proper phase position, and the instantaneous speed fluctuates above and below its proper synchronous value. The action is very much as if the transmission of energy between the alternator and the motor were accomplished mechanically by means of elastic cables. Then, as the angular velocity of the driving pulley varies, the cable would stretch but tend to change the velocity of the driven pulley at the same time. If the natural period of oscillation of the driven pulley be equal to or a multiple of the period of change in angular variation in the driver, it is seen that a condition of mechanical resonance prevails, and that the amplitude of oscillation of driven pulley with respect to the driver will increase, and with it the force tending to rupture the cable. Owing to the inertia of the driven pulley, there will be a time lag in its response to the tension of the cable. If the cable (which corresponds to the synchronizing power of the motor) is of sufficient strength, there simply results a mechanical (or, with the motor, a combined mechanical and electrical) oscillation which may or may not be harmful. In a converter, the pitch of two poles is called 360 electrical degrees. If the mechanical oscillation around synchronous speed causes an electrical displacement beyond a certain point, the torque decreases and the motor falls out of step and comes to rest. If this point is not reached, the motor rotating-part simply oscillates backward and forward with respect to that of the alternator. If the ammeters in the circuit are undampened they show a kick of the needle at each revolution of the engine, and frequently a slight sound is given out by the iron of the motor. In this manner the speed of the driving engine is exactly indicated by the motor, even though they be at different ends of long lines.



ROTARY CONVERTER, 3.500-VOLT POLYPHASE CURRENT TO 260-VOLT DIRECT CURRENT.

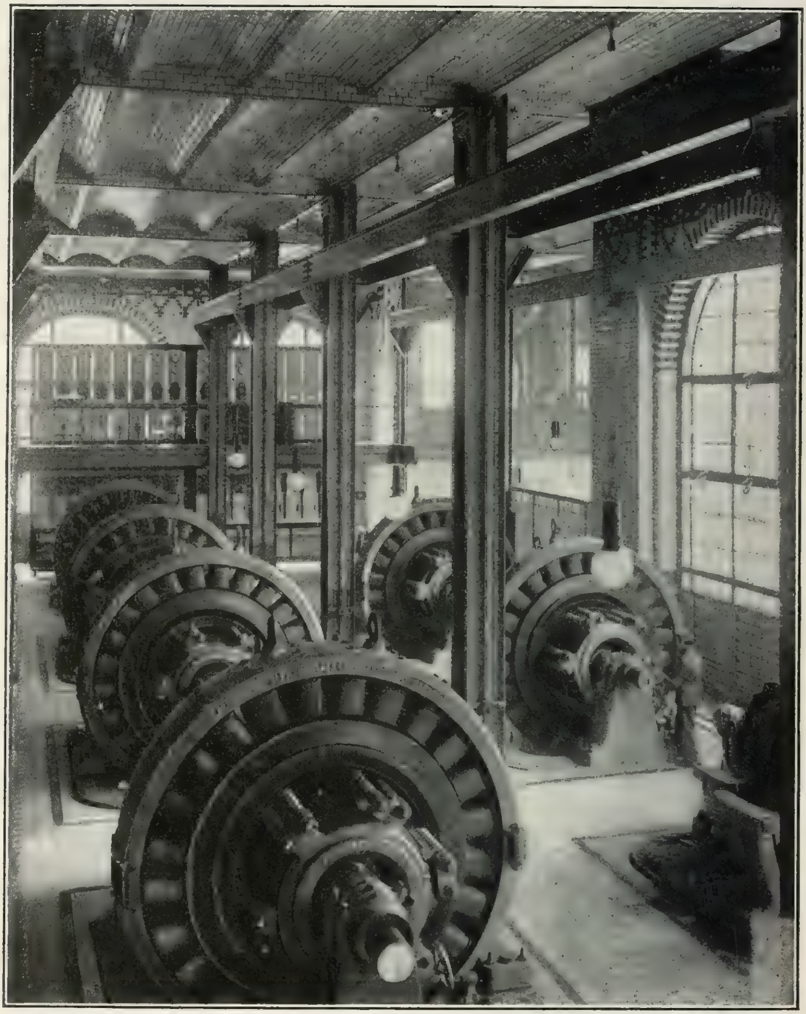
350 kilowatt, 375 revolutions and 50 periods; synchronous motor of 525 horse power. Built by the Maschinenfabrik Oerlikon, Oerlikon near Zürich.

With regard to the use of flywheels or of flywheel effects in converter armatures, there is some difference of opinion. Were the revolving part entirely without mass, the speed of the rotor would correspond exactly with the frequency at all times. If the natural period of oscillation of the converter armature bears a certain relation to that of the varying angular change in the generator such that resonant effects will result, the addition of a proper flywheel effect will change the natural period of oscillation and tend to smooth out the variation. In general, flywheel effect would seem to be helpful, viewed from this standpoint, when the variations are only those which occur regularly during a revolution of the engine. In order that alternators may run in parallel satisfactorily, it is best that the engines do not regulate too closely—that there be a perceptible, although small, drop in speed under load. When converters operate on railway systems, there is liable to be large and sudden variation in load, extending over some period of time. In this case the converter armature can follow that of the generator more closely as the flywheel effect is less. Where damping devices are used, the energy dissipated therein for a given displacement will be greater with flywheel effect than without. Whether the displacement would be sufficiently less with the added inertia to reduce the loss of energy as a whole, would depend upon the conditions in the individual cases. Variation in angular velocity, while an important source of hunting troubles, is only one of a number of causes which



750-HORSE-POWER SINGLE-PHASE MOTOR GENERATOR IN THE SUB-STATION OF THE FRANKFORT TRAMWAYS.

Built some years ago by Brown, Boveri & Co., of Baden, and interesting because the alternating-current motor is single-phase. The continuous-current dynamo gives current at 550 volts.

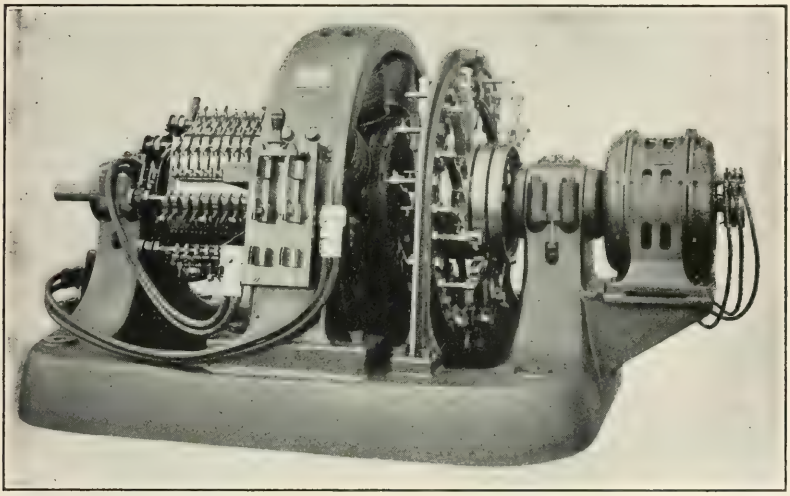


TRANSFORMER ROOM IN THE MARIANNEN-STRASSE SUB-STATION OF THE BERLIN ELECTRICITY WORKS.

As the works have extended, additonal central stations within the city limits have been impracticable on account of the high cost of land and difficulties of fuel and water-supply. The system adopted therefore has been the erection of central stations outside of the city limits, generating polyphase current at 6,000 volts, which is transformed to direct current for lighting, power, and traction service at five city sub-stations. The one shown above has a capacity of 8,770 kilowatts, and was installed by the Allgemeine Elektricitäts Gesellschaft, Berlin.

may produce this result. The lack of armature reaction in a converter under best conditions of operation gives it a greater instability than a synchronous motor, while in the above the action of the two has been considered the same.

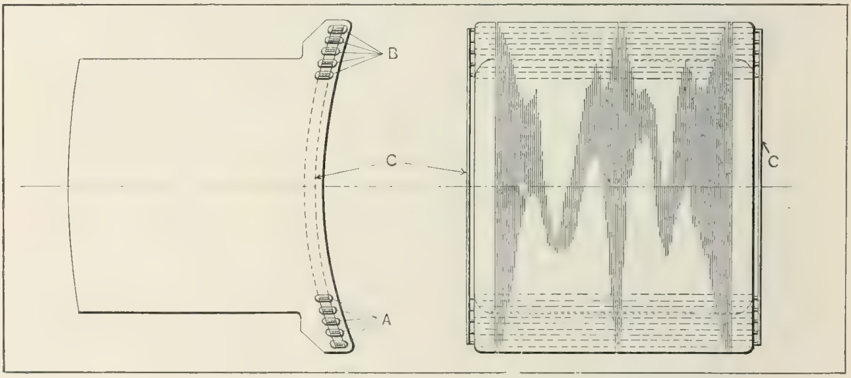
Any cause which varies the voltage impressed on the converter terminals will tend to produce hunting. This may come from too-high resistance or inductance in the line. The absence of armature reaction in a converter is due to a balance between two equal and opposite forces. The brushes being set at the neutral point, the effect of the continuous current is to distort the field in the direction of rotation, there being no demagnetizing effect. The reaction of the alternating current at unity power factor is equal to that of the continuous current in value and is opposite in direction. If either of these is altered or removed, the influence of the resultant is of course felt. At other than unity power factor there is a wattless component of the alternating current—that is, a component which represents a transfer, but not a utilization, of electrical energy; and this has a demagnetizing effect upon the field. If, with a sudden load coming on the converter, a drop in applied voltage due to line resistance or inductance takes place, the sluggishness of the magnetic circuit and the inertia of the armature prevent an instantaneous adaptation to the new conditions, and the counter electromotive force is too high. This causes a sudden pull on the armature to change the phase relations of current and electromotive force, and an impulse tending to cause the rotation to depart from synchronous speed is given to the armature.



ROTARY CONVERTER FOR SIX-PHASE ALTERNATING CURRENT, DELIVERING DIRECT CURRENT AT 110 VOLTS.

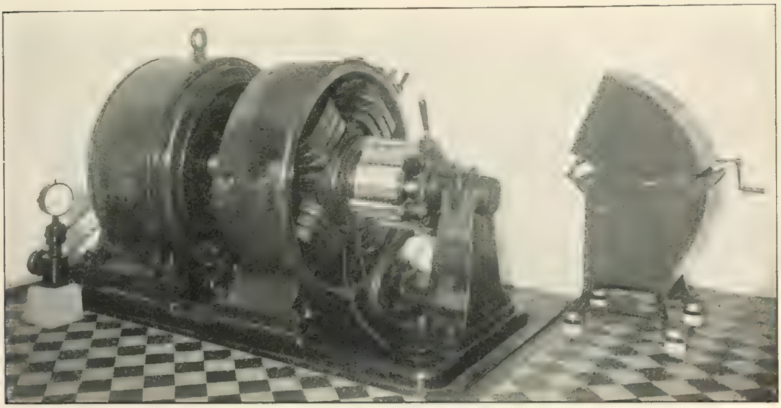
Union Elektricitäts Gesellschaft, Berlin.

The magnetic result of a tendency to hunt is a shifting of the lines of force of the field across the pole face. At one instant the alternating-current reaction will be too great and the lines will be crowded to one pole corner. Then this will weaken, and the continuous-current reaction will crowd the lines to the other corner. This causes a shifting of the lines of force across the interpolar space and produces sparking. To prevent this, the armature teeth and the pole corners may be worked above the point of magnetic saturation, and copper rods or strips may be so placed at the pole corners that any incipient shifting of the field produces a powerful reaction. Below is shown a device for this purpose. A number of ducts are placed in each pole corner. Through these are run heavy copper conductors, A and B, which are short-circuited together at the ends by bars C, C. The ducts at the corners are so proportioned that the iron is highly saturated between them. With iron worked at this point, a considerable increase in magnetizing force but slightly increases the flux, and a considerable decrease in magnetizing force decreases the flux slightly. Therefore a variable armature reaction can cause but slight distortion of the field. What shifting of the field does result causes heavy currents in the conductors, which at once stop the change. With the conductors placed in this manner all of the currents induced are in a direction to produce useful result and no energy is unnecessarily wasted. They cause no decrease in the already small mechanical clearances of converters. The variations of magnetic flux at the pole face of very high frequency due to the slot openings cause no unnecessary loss, the circulation of air is not obstructed, and there is no danger that the device may work loose and strike the armature. Copper strips inserted under the pole corners are also used for the same purposes.



ANTI-HUNTING POLE PIECE FOR ROTARY CONVERTER.

Where alternators are driven from turbines or from steam engines giving a nearly uniform angular velocity, and especially on systems

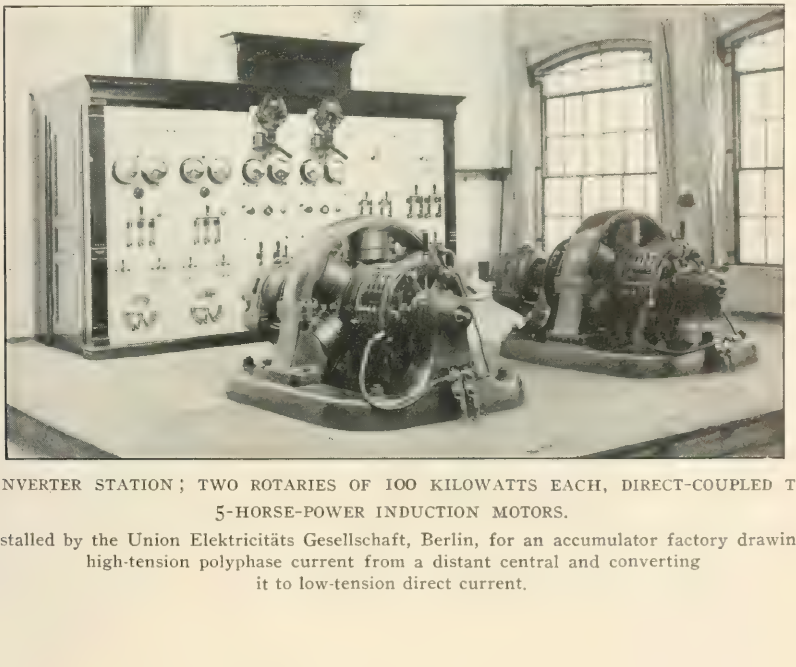


CONVERTER IN THE "PRINZREGENTEN-THEATRE" SUB-STATION, MUNICH.
Installed by the Allgemeine Elektricitäts Gesellschaft, Berlin. Takes polyphase current from the circuit of the city electrical works and furnishes direct current for the theater.

where converters are operated in conjunction with storage batteries, hunting is unknown. In most cases it has more of a theoretical than practical interest, and in but few cases is it a source of serious trouble.

Starting. Converters are not in general self-starting from rest, and some device is necessary to bring them up to speed, as with a synchronous motor. There are three usual methods of doing this.

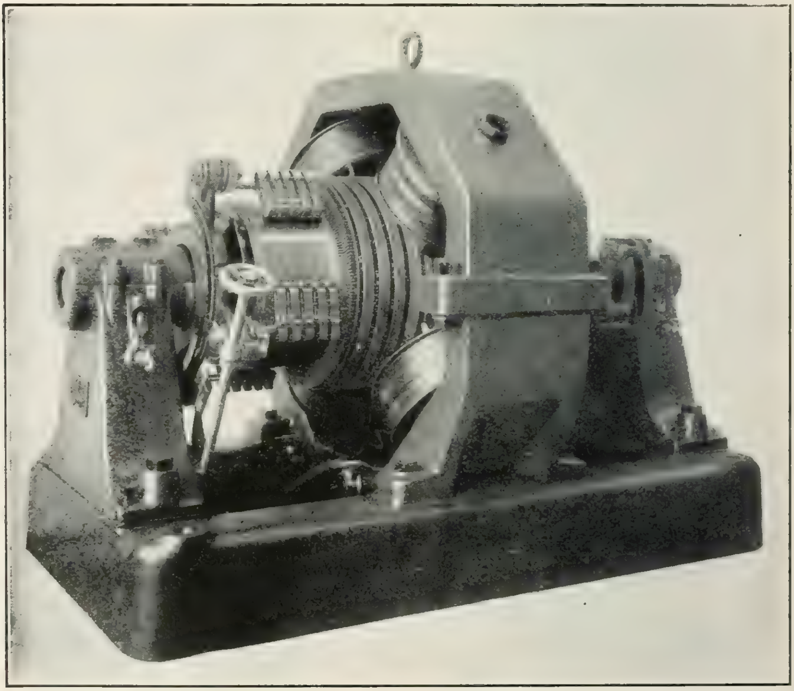
First, the converter may be thrown directly on the line through impedance coils or auto-transformers. An impedance coil is simply an



CONVERTER STATION; TWO ROTARIES OF 100 KILOWATTS EACH, DIRECT-COUPLED TO 5-HORSE-POWER INDUCTION MOTORS.
Installed by the Union Elektricitäts Gesellschaft, Berlin, for an accumulator factory drawing high-tension polyphase current from a distant central and converting it to low-tension direct current.

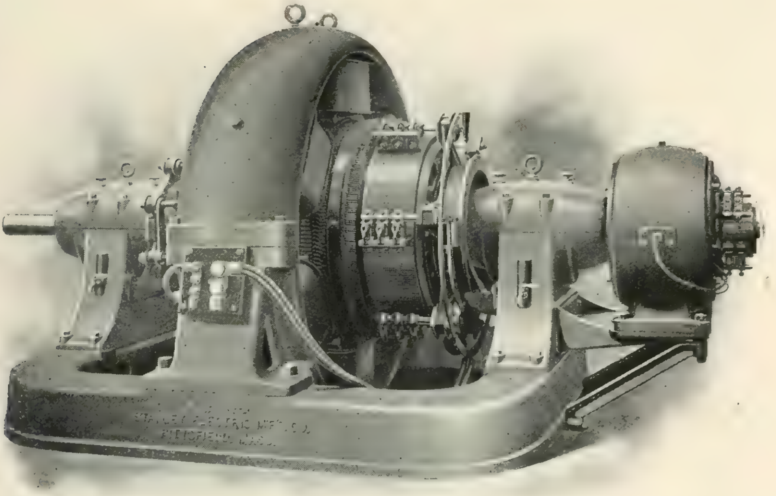
iron core on which is wound wire. This is placed between the line and the converter armature, and acts to choke down the voltage and prevents the great rush of current and consequent disturbance of the line which would occur were the normal voltage thrown directly upon an armature which was at rest. Often a number of taps are brought out from the winding, and the coil is cut out gradually as the armature comes up to speed, until it is entirely short-circuited, when synchronism is reached. This arrangement reacts upon the main line. As the starting current is usually greater than full-load running current, and at a low power factor, very little energy being consumed, the disturbance may be more or less undesirable, depending upon the conditions in each case.

With the auto-transformer we have one winding upon an iron core, as in the case above, but the terminals are connected across the line instead of in series with it. Taps are brought out at different points, and the voltage impressed on the converter may be made as low as desired. As the speed rises the voltage is raised, until full voltage at



100-KILOWATT ROTARY CONVERTER FOR AN EXTENSION OF THE MANCHESTER CORPORATION PLANT.

Transforming three-phase current at 260 volts and 30 cycles to direct current at 416 volts; runs at 900 revolutions per minute. Built by Brown, Boveri & Co., Baden.



350-KILOWATT ROTARY CONVERTER. STANLEY ELECTRIC MANUFACTURING COMPANY, PITTSFIELD, MASS.

synchronous speed is reached. The auto-transformer reduces the line current at starting in proportion as the applied voltage is lower than that on the line, and thus causes less disturbance than the impedance coil. As either of their coils is in use for but a very short time, they need not be large in order to fulfil their function.

A second method of starting converters is to mount, on the end of the shaft, a small induction motor, the synchronous speed of which is higher than that of the converter. The induction motor is then thrown across the transformer secondaries and brings the converter up to speed, after which it is cut out and runs idly under normal operation.

A third and most desirable method is, wherever possible, to start the converter from the continuous-current side as a shunt motor. There is no disturbance whatever to the line, the current drawn is small, and trouble with regard to obtaining the correct continuous-current polarity disappears. Where a number of converters are in a sub-station it is good practice to install a small self-starting converter or a small motor-generator set in order to obtain the continuous current.

When converters are started from the alternating-current side they act as hysteresis motors. The current in the armature induces a magnetic field in the pole pieces. As the iron has hysteresis, the induced field lags behind the current producing it and thus produces a torque.

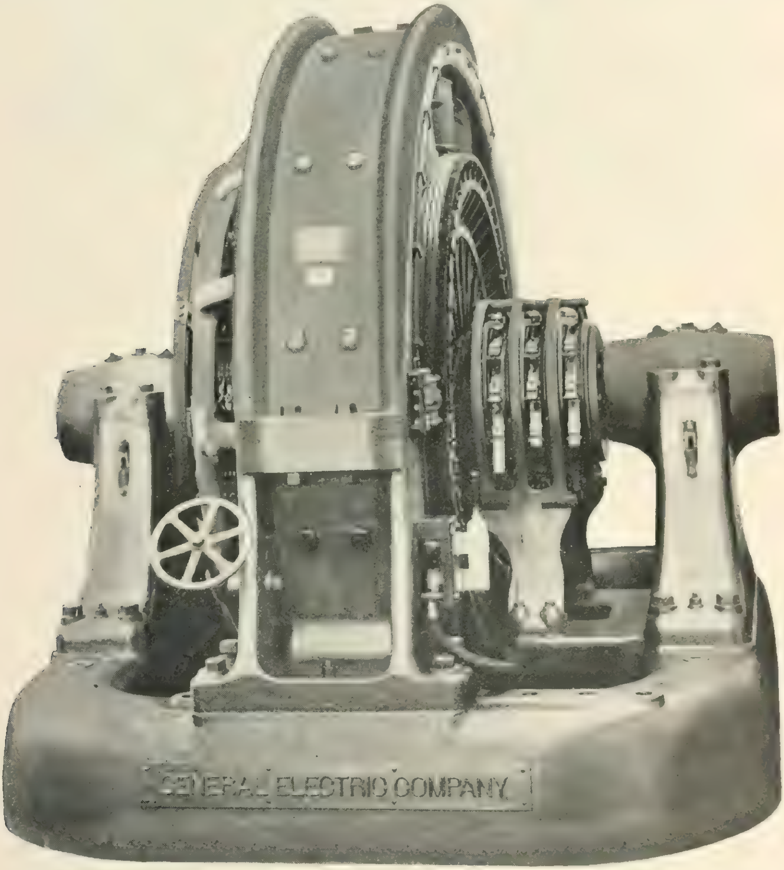
Converters with solid or laminated poles start with about the same apparent energy as measured by the volt-ampere input, but in the case of laminated poles the current is more in phase with the electromotive force. This is due to the fact that the magnetizing current necessary to produce the field is less by reason of the subdivided iron, which allows the induction to penetrate farther into the pole.

This transformer action in the field pole causes the generation of a considerable voltage in the shunt coils, which may rise to a dangerous height and injure the insulation if means are not taken to prevent it. The field circuit may be opened in several places and thus the addition of the voltage prevented. The field may be short-circuited upon itself, and a small but harmless current allowed to flow in the coils. This voltage may be considerably higher with laminated than with solid poles.

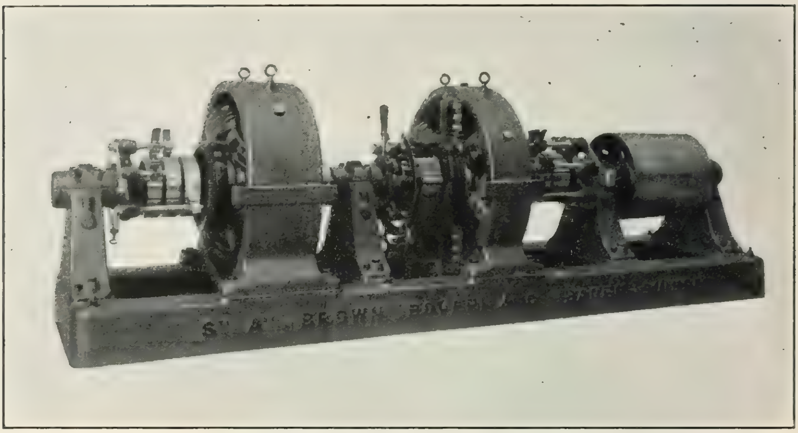
The "Inverted" Converter. The inverted converter is one used to transform continuous into alternating currents. Frequently it is desirable to extend the area which can be covered from a continuous-current power house. The distance may be considerable, but the amount of power small and insufficient to warrant the installation of an alternating-current generator. In this case, alternating-current transmission from an inverted converter in the power house is often wise. When, with further extensions of the system, alternating-current generators are used, the machine may be placed out on the line and used as a regular converter.

No radical difference exists in converters used for either purpose, and the principal point demanding attention when they run from continuous currents is that of speed control. With the alternating current there is a fixed synchronous speed which cannot be exceeded. On the other hand, there is nothing of the same nature to determine definitely the speed of a shunt motor, in which function the inverted converter operates. This, for a given machine, is determined by the field strength and by the impressed voltage. Under normal conditions of operation there is an absence of armature reaction in a converter, the air gap is small, the field comparatively weak, and a large number of conductors are wound on the armature. If the brushes are displaced from the neutral point, if the power factor (the ratio of actual to apparent energy) becomes low, or if, with a saturated magnetic circuit, the voltage is suddenly raised, the speed of the converter armature may increase beyond desirable limits. Two methods are used to prevent this danger and to keep the possible variation down to a few per cent. on each side of normal.

The first and better method is to excite the converter separately from a small exciter either mounted directly upon the shaft or else belted to it. The magnetic circuits both of the exciter and of the converter are worked below the bend of the saturation curve. The usual cause of speed change would be a variation of an inductive alternating-current load. Suppose the converter to be running at the proper speed and this to happen. The inductive alternating current will react on the field and weaken it. In order that the counter electromotive force of the shunt motor may then equal the impressed, the motor with its weakened field must run at a higher speed. As soon as the speed begins to rise the electromotive force of the exciter rises much more rapidly, on account of its unsaturated circuit, and the field current is increased and with it the magnetic flux and counter electromotive force



1,000-KILOWATT CONVERTER, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.



AUXILIARY SET BUILT BY BROWN, BOVERI & CO. FOR DOLLFUS MIEG & CO. OF MULHAUSEN.

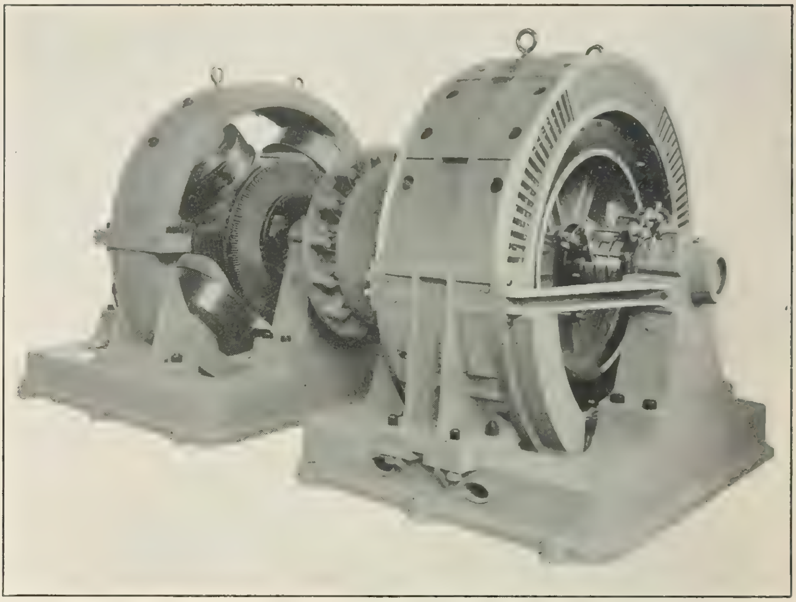
Serving as a connecting link between two alternating-current systems and as an exciter for a 1,200-horse-power three-phase generator. The set consists of:—(a), a synchronous alternating-current motor for three-phase 78 volts and 45 cycles; the motor runs at 900 revolutions, and the machine has a commutator so that it will give simultaneously 24 kilowatts for the excitation of a large generator and 63 horse power for driving the alternator; (b), the three-phase alternator for 60 kilowatts at 220 volts and 30 cycles. Driven by belt, instead of by the supply current, the set will give continuous current at 120 volts, three-phase at 75 volts 45 cycles, and three-phase at 220 volts and 30 cycles.

and the increase of speed ceases as soon as balance is obtained. If the load suddenly goes off the converter, the reaction disappears, the field is strengthened, and the tendency would be for the speed to fall. The instant this begins to occur the voltage of the exciter drops rapidly or dies away altogether. This weakens the converter field and makes a higher speed necessary for the generation of the proper counter electromotive force, which immediately checks the decrease of speed. In practice this method of control will keep the speed constant within a few per cent. on each side of the proper value. The counter electromotive force in a motor must equal the impressed voltage less a small drop due to resistance. Thus weakening the motor or converter field increases the speed, while strengthening it produces the opposite result.

The other method of speed control is to mount on the shaft of the inverted converter a small auxiliary converter, having the same number of poles but possessing no field winding. Series transformers are placed in the outgoing alternating-current lines and the current from them runs to the alternating-current rings on the small converter. The continuous-current brushes are in series with the field of the main converter. If the outgoing alternating current tends to weaken the field, the reaction in the small converter increases the exciting current and thus strengthens it. Should the alternating current tend to strengthen the field, the auxiliary converter will weaken it.

Compounding. The compounding of a converter is a very different action from that which takes place in a continuous-current generator. In the latter, if we wish to increase the voltage under load, we wind series coils on the poles, which increase the field and voltage as the output rises. It is one of the strange properties of a converter that, if the applied alternating voltage be kept constant, we can not vary the continuous electromotive force by increasing or decreasing the field excitation. If the counter electromotive force of the motor is below that applied at the terminals, the character of the alternating current becomes somewhat changed and it reacts upon the field in such a manner as to increase it to a point where the proper counter electromotive force is generated. The component of the alternating current which does this does not represent an expenditure of energy, except as it increases the resistance loss in the conductors. It does, however, in practice produce a harmful effect upon the generator and line by causing a greater drop in voltage. If, on the other hand, the counter electromotive force of the converter is too high, a component of the alternating current flows in the armature, which decreases it. The reaction of this on the line is nearly always helpful in lessening the voltage drop and producing more satisfactory operating conditions.

The drop in voltage in transmission lines and electrical machinery is due to two causes. First, there is a resistance drop which represents an expenditure of energy which appears as heat in the conductor. Second, there is a drop due to the fact that a magnetic field is always formed around conductors carrying a current. The energy which appears in this magnetic field is not expended, but simply stored to be returned to the circuit when the current decreases. If we pass alternating current through a choke coil we get a drop in voltage due to this magnetic effect which is many times greater than the resistance drop. If we applied 1,000 volts continuous current to the proper coil of a static transformer a tremendous rush of current would follow which would quickly destroy it. Should the current be alternating, of the proper frequency, but a very small and harmless current will flow which will not even heat the conductors. The bearing of this upon the compounding of a converter is, that this can only be done when in the line leading to the machine there exists a certain amount of choking effect usually spoken of as inductance. Where the lines are short and the currents small, artificial choke coils are often placed in the line to



ROTARY CONVERTER, POLYPHASE CURRENT AT 6,000 VOLTS TO DIRECT CURRENT AT 450 VOLTS.

230 kilowatts, 370 revolutions and 50 periods; a synchronous motor of 350 horse power. Maschinenfabrik Oerlikon.

produce this effect. This occasions a considerable drop in voltage across the coils. Now the excitation of a converter may be so adjusted that, as the continuous-current load increases, the relation which this inductive drop bears to the line voltage will be such that they will add together and thus increase the alternating electromotive force impressed upon the converter terminals. The ratio of transformation in the converter being practically constant, the continuous-current voltage will be raised. The amount of this increase may be sufficient to compensate for the drop in pressure due to other causes, or it may be sufficient to increase the voltage as the load comes on, and overcompound or act as a booster. Varying the field excitation without at the same time varying the applied electromotive force, has practically no effect upon the continuous-current voltage and serves only to increase the alternating current.

Another method of varying the continuous-current voltage is to use regulators on the transformer coils. The possible range of voltage at which converters may be worked requires that in nearly all cases transformers be used to step down the pressure before it be led to the collector rings. The voltage on these may be varied by bringing out a number of leads, to be cut in or out as a change in voltage is desired.

THE RUSSIAN LAW OF GOLD MINING.

By C. W. Purington and J. B. Landfield, Jr.

The article below supplements the preceding study of gold-dredging possibilities in Russia, by the same collaborators, and the earlier paper by Mr. Purington on lode mining for gold in Siberia, both lately published in The Engineering Magazine. They gave an idea of physical conditions; this summarises the statutory conditions under which mining enterprise—so far at least as the precious metals are concerned—may be prosecuted in the Russian Empire. To this section Mr. Landfield's thorough knowledge of Russia and the Russian language has been particularly valuable.—The Editors.

THE mining law in force in the Russian Empire has as its fundamental principle the tenet that mineral wealth is movable property, and bears no relation to the estate on which it is found. The right of the operator to hold the ground ceases when he shall have exhausted the mineral resources therein contained. In other words, the tenure by which claims are held, as will be seen by reference to the following articles of the mining code, is practically perpetual lease from the government—that is, absolute title guaranteed so long as the small annual taxes are paid. The provision that the tenure is good until the mineral is exhausted is explained by the fact that until recently almost all the gold-mining of Russia and Siberia was placer mining, and that when the gravel had once been worked over it was intended that the operator should not stand in the way of further development.

The following outline of the law as it relates to gold mining is taken from the "Digest of Mining Statutes and Monetary Law," fifth edition A. F. Skorof, Moscow, 1900. (In the Russian language.) The translation as given is only sufficiently full for the purposes of clearness.

Sec. 263, 264, 265, 266, 267:—The pursuit of the mining industry, including the locating and the patenting of claims, on free government lands, is allowed to persons of all conditions possessing rights of citizenship, Russian subjects or foreigners, with the following exceptions: Members of the secular clergy; officials connected with the mining bureau of the Department of Agriculture and Domains, and members of their families; certain classes of Jews, in those portions of the empire where the law forbids them to reside; criminals whose civil rights have been forfeited; and, in districts in which they serve, all police officials whose duties are judicial or have to do with the mines.

In the Maritime Province (which includes all the Pacific coast of Siberia), none but Russian subjects are allowed to pursue mining. This regulation, (432, note) was decided on as far back as 1885. Special permits for foreigners to pursue mining in the Maritime Province have been given in rare instances.

Sec. 427:—Gold deposits situated on the free government lands, or on those belonging to the cabinet of His Majesty the Emperor, are placed at the disposition of private operators, the land being held not as property, but in temporary holding, up to the exhausting of the mineral resources.

Sec. 417, 418:—The exploitation of gold placers and veins is allowed, according to the regulations set forth in Secs. 416-540 of the Code, with certain exceptions in the Ural, Altai, and Nerchinsk districts, and in the Maritime Province.

Sec. 428:—The possessor of a tract of gold-bearing gravel enjoys, as long as he possesses it, the right to the lodes which are found within the concession, without demanding a special authorization to this effect, and without paying on this account a supplementary tax. But the making of a declaration to the local agent of industrial surveillance is required. In the same manner, the holder of a tract given for the exploitation of a lode has the right to exploit gravel situated on his ground.

Sec. 430:—The right of the gold miner to the deposit exploited by him is considered as that to movable property, chattels, (*imushtchestvom dvizhimim*), according to Art. 403 of the Civil Code.

Sec. 437:—The persons authorized to exploit gold veins and placers have the right, conformably to the principle of common law, to form, and to become members of, companies for that purpose. Copies of the by-laws of the company must be presented to the local mining office and to the Department of Mines.

Sec. 440:—To undertake the prospecting for auriferous gravel-deposits and gold-bearing lodes, each person, or each company, must provide himself or itself with a prospecting permit.

(Such permits, good for the whole of eastern Russia and Siberia, with the exceptions above-mentioned, are easily obtained from the mining offices in Ekaterinburg, Tomsk, and Irkutsk. They are given on proper application, accompanied by the passport of the applicant. The cost is nominal, from $2 to $3. The permits are good for life.)

Sec. 444:—The prospector (provided with his permit) must give notice to the local mining office, before setting out, specifying the members of his party, what papers they possess, and the time and starting-point of the expedition. In the districts of eastern Russia the local police must also be notified.

Sec. 448:—The ground located is indicated, if a gravel deposit, by two stakes marking the extreme points and inscribed "occupied such a day, such a month, such a year, by such person or company for prospecting purposes." If it be a lode claim it is marked by a single stake, with the same inscription repeated on its four faces.

Sec. 451:—If, after testing, the ground is considered worth declaring as a mining location, it is required that two pits be dug, and one prominently marked stake be left to hold the location.

Sec. 453, 460:—An exact description of the ground located must then be prepared in four copies, one of which is sent at once to the district police, the others to the local mining office, the district mining engineer, and the local land office.

Sec. 463:—All re-locations of a mine already located are counted void, even if the law has not been complied with for obtaining patent; (i. e., a would-be claim-jumper has no status in court even if the original locator has not complied with the law.)

Sec. 467, 468:—As soon as possible, but at longest within two years, a government survey and platting of the claim is ordered by the district engineer. This corresponds to a land-office patent in the United States. (In practice a petition is made by the locator to the district mining office, if he cares to have the survey made at his own expense. In this way it is done much more expeditiously, and the expense is very slight.)

Sec. 475:—The area of claims is as follows:—1, in east and west Siberia, the entire length of one placer claim must not exceed five versts (17,500 feet) up-stream from the location stake; in width it may take in the breadth of the valley, to a limit of 1,750 feet on either side of the main stream. 2, in the Ural and other portions of European Russia, the length of the claim must not exceed 17,500 feet, and it must measure not less than 700 feet in width, in such a manner that the entire area of the claim does not exceed 250,000 square sazhenes (280 acres, very nearly). 3, a gold-quartz claim may have any dimensions, so long as it does not exceed one square verst, or 280 acres, in area, and providing its width measures at least one-third its length.

Sec. 533:—Land held for gold-mining purposes is subject to an annual tax after patenting. In the Olekma district of east Siberia this tax amounts to $1.80 per acre annually. In the Amoor district, to $0.60 per acre annually, and in the rest of Siberia, and the Ural, to $0.18 per acre annually.

Sec. 782:—The auriferous lands are divided into three categories:—1, the Olekma district; 2, the Amoor district; and 3, the remainder of the Siberian districts, the Perm and Orenburg governments of the Ural, and the Kirghese steppes. The tax on the gross output of gold is fixed at 10 per cent. for mines lying in the first category, 5 per cent. for those in the second, and 3 per cent. for those in the third.

Sec. 782:—All the placer gold and bullion obtained in the course of the operations must be recorded by the mine management in gold-books, margined and paragraphed.

Sec. 783:—These books are prepared by the operators, who must present them at the latest by the first of January, each year, to the local mining office, to have them countersigned and sealed, after which the said books are given back to the operators not later than the first of March, each year.

Sec. 787:—-The gold extracted by the operators must be delivered by them, under their seal and with the certificate of the district engineer or his representative, to the government assay office, either at Ekaterinburg, Tomsk, or Irkutsk, according to the district in which the mine is located.

Sec. 788:—As it comes in it is weighed, run in bars, and assayed on four faces in presence of the operator.

Sec. 789:—After the weighing and assaying of the bullion a detailed return is made out, specifying the quantity of the pure metals and the price to be paid according to the rate of conversion, with deductions for tax, transport, coinage charges, etc.

Sec. 791:—As guarantees of the amount due them, the mining department issues to the operators orders on the St. Petersburg Mint, for any sum exceeding 150 roubles, good for six months.

Note 3; These orders are immediately negotiable at local banks or private hands.

It is, of course, not to be denied that certain features in the system of administration above outlined are trying to the operator, especially to one accustomed to western modes of thinking and procedure. Siberians, even when carrying on operations of considerable magnitude, and in localities widely separated from one another, appear to have no difficulty in complying with all the numerous regulations in regard to gold-mining. The employment of numerous clerks, men who are entirely familiar with the mining law and its requirements, facilitates matters to a large extent. Scribes of all kinds, as well as mining surveyors and draughtsmen, command very small pay in Russia and Siberia, and the quality of the work done by them is excellent.

The expenses of locating and patenting claims in the Ural and in Siberia is very little. The size of the claim being optional with the locator, up to 280 acres, he rarely finds it of advantage to include more than 200 acres within his lines. The average cost of locating and patenting such a claim, including all field and camp expenses, will not exceed $125. Particularly noteworthy throughout the mining code is the effort to give perfect title and to prevent litigation. All locations must be patented within two years and no title or assessment work is required. All of the court decisions under the mining code show the precedent that failure to comply with the unimportant and purely formal technicalities of the law does not interfere with a man's title. To those who have mined in other parts of the world, perhaps the most striking feature is the large amount of land that can be located in a single claim. This liberality has, as a matter of fact, been the chief obstacle to the progress of Russian mining, as it has enabled unprogressive men to hold large tracts of valuable mineral land without being obliged to do assessment work thereon, but simply sit still and wait for a purchaser.

The complete statistics of the industry obtained by the Government, through its inspection and purchase of all the gold, are really of great advantage to prospective purchasers of Russian or Siberian mines, though their accuracy is sometimes affected by the clandestine purchase of gold by local operators, turned in as their own product. The features of the code providing for careful government supervision resulted from the exigencies of the convict system, and the requirement that all gold be sold to the Government. Now that the sending of convicts to Siberia has been done away with, this supervision is much less important; nevertheless, the code provides carefully for various governmental inspections, which have as their object the protection of the health, safety, and welfare of the laborers, and the prevention of the clandestine traffic in gold. There is the amount of red tape that might naturally be expected of a code enacted by central officials in a bureaucratic government, but in practice most of these provisions are dead letters. The mine operator who is not impatient or overbearing and who will exercise a reasonable amount of tact and courtesy, as well as deference to ingrained local prejudices, will have no difficulty.

Personal experience in the locating and patenting of mining claims, and in actual operations on the ground under the Russian law, has convinced the writers that the numerous rules which must be observed are not nearly so great a hindrance to production as might at first appear. If, on the one hand, the gold miner is closely watched by the government mining department and its branches, he also receives a protection of his territory and mining rights which renders him secure from the dangers of litigation. The administrators of the mining department, especially those high in authority, the writers have found to be men of progressive ability, disposed to render every courtesy to the law-abiding foreigner.

That it is the desire of those in authority to see an increase in the gold production of the Empire can hardly be doubted in view of the fact that each year fresh concessions are made in favor of the miner. Notable among these was that of 1898, by the provisions of which all foreign machinery intended for gold-mining purposes, entering Russian territory at whatever point, within ten years after the passage of the law, pays no duty.

PRACTICAL APPLICATIONS OF REINFORCED CONCRETE.

By Jacques Boyer.

In view of the widely extending use of combinations of concrete and metal, and the importance of the intelligent and scientific applications of the method as opposed to empirical and arbitrary designs, the following exposition by Professor Jacques Boyer of the development and progress of reinforced concrete will be found both valuable and interesting. The most extended applications of this form of construction have been made in France, and it is by French engineers that the most thorough and scientific study has been given to it; and while other parts of the world have not been neglected, it is from France that the greater portion of the experience and illustrations for Professor Boyer's papers has been drawn.—THE EDITORS.

THE discovery of cement is credited to two Englishmen, Parker and Wyatt, who obtained this product for the first time by the calcination of argillaceous nodules (1795), and since that date it has found innumerable applications in every department of civil engineering. Among these applications of later date came the invention, by Léon Coignet, of *béton* or concrete, of which he made artificial blocks as hard as natural stone. It has been impossible to discover to whom the engineering profession is indebted for the idea of imbedding a metallic skeleton structure within a mass of hydraulic mortar or concrete, but a boat constructed in this manner was shown at the Paris exposition of 1855; about the same time Coignet built some dams of iron and concrete, and five years later he applied the method to the construction of floors. These early combinations, however, did not show a satisfactory resistance to tension, and the system was considered too dangerous for use in building construction. It has been only within the past ten years that practical engineers have undertaken to reinforce the portions of a structure under tension by members of iron imbedded in concrete, deducing the rational methods of construction now known and included in the general term of reinforced concrete *(ciment armé)*. Very recently, in consequence of the successful experience of MM. Cottancin, Hennebique, and Monier, in France; of Melan, in Austria and Germany; and of Hyatt, Jackson, and Ransom, in England and America, this method of construction has been welcomed and accepted very generally. A study of the various systems and methods should therefore form a subject of interest to every engineer who desires to keep abreast with the progress of the profession.

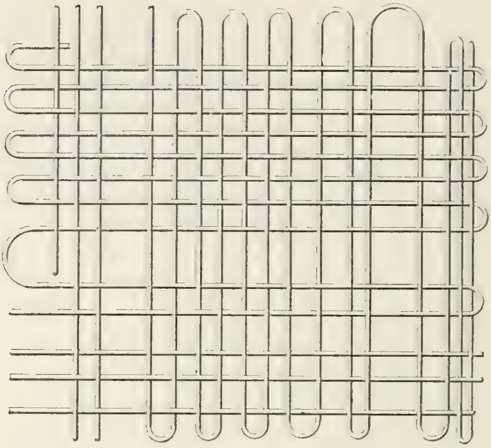


FIG. 1. LATTICE-PATTERN REINFORCING SKELETON, COTTANCIN SYSTEM.

Skeleton structures of the principal systems:—At the present time the term reinforced concrete is understood to refer to a structure composed of a metallic skeleton imbedded in a mortar of cement concrete. This definition being accepted, we may pass successively upon the methods adopted by the principal constructors.

The first applications of the Cottancin system go back to the year 1889. This system consists in the preparation of a network of iron wire of varying mesh, corresponding to the varying loads which are placed upon the different portions of the concrete structure. The methods of arranging the network adopted by M. Cottancin differ according to circumstances. (Figures 1 and 2.) The arrangements most frequently adopted are those in which the reinforcing wire is woven back and forth between through wires, so as to bind the various parts of the system thoroughly together, the weaving being closest at the points of heaviest loading, as has already been noted above. Since the employment of a very close mesh is apt to prevent the concrete from filling the interstices completely, it is found advisable instead to use at the points of heaviest loading rods of heavier section than those of 4.5 millimetres diameter ordinarily employed.

The metallic skeleton of the Monier system is less complicated, being formed of two lines of horizontal rods, intersecting each other at right angles. (Figure

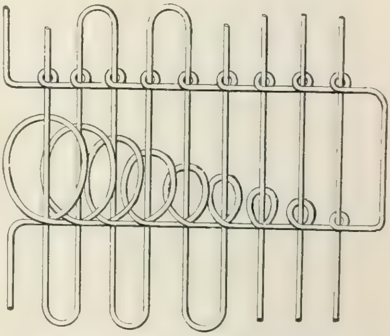


FIG. 2. CONTINUOUS SKELETON WITH WOVEN SPIRAL, COTTANCIN SYSTEM.

3.) The lower rods *a*, called the resistance members, are spaced 10 centimetres apart, and are made of a section varying with the load to be supported. The upper, or partition rods, are bound to the lower ones by wire ligatures of 1 millimetre in diameter at the points of intersection. When the load is very heavy several combinations of this kind are used together.

The Hennebique system is based upon the following principle, viz., the provision, in a beam of concrete, of the necessary resistance to tension, which it otherwise lacks; this being accomplished by the means of tension members of iron suitably placed. The upper, or compression, portion of the beam of concrete is connected to the iron rods of the lower, or tension, portion by means of stirrups of flat iron, the structure thus corresponding, so far as distribution of stresses is concerned, to a standard I beam; the whole being imbedded within the mass of concrete. (Figures 14 and 15.)

The Bonna system of reinforced-concrete construction differs materially from other methods. This engineer aims not only to produce a monolithic structure of concrete, but also to provide it with a complete metallic skeleton. In fact the skeleton of an edifice constructed according to this system is distinguished from that of an ordinary building only by the lightness of the framework, the small number of bolts, and the total absence of braces and reinforcing plates. The principal purpose of the employment of bolts and connecting members is to sustain the framework, and maintain it in position until the concrete has set and become hard. This construction enables the computations for resistance to be applied in a very advantageous manner, and with great economy of material. In practice, rolled sections are preferred to round rods, because of the rigidity which they possess apart from the support of the concrete. In fact, when round rods are employed it is necessary to provide for the dislocation which would take place under the weight of the concrete itself before it becomes hard and is united to the metal. Unless such precautions are taken the reinforcing members of iron rod or wire may be so changed in position as to affect materially the strength of the combination. It is much easier to erect a structure of rolled sections than one of round rods, and since the framework is self-sustaining it may be completed before the concrete is applied.

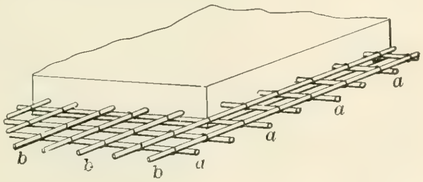


FIG. 3. REINFORCEMENT ON MONIER SYSTEM.

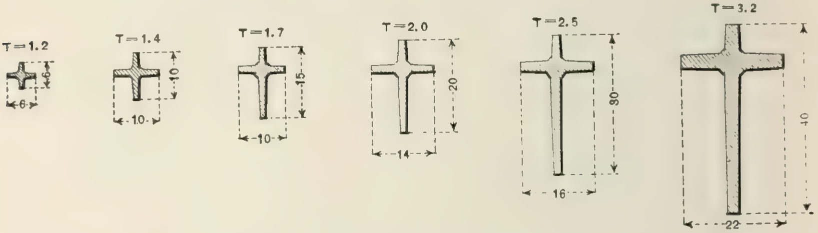


FIG 4. PRINCIPAL STEEL CROSS-SECTIONS EMPLOYED IN THE BONNA SYSTEM.
All measures are in millimetres. T = thickness.

The sections usually employed in the Bonna system are in the form of a cross, of rolled steel, examples being given in the illustrations, Figure 4. These range from 110 grammes to 1.75 kilogramme in weight per running metre, the moment of inertia being much greater than for round bars of the same sectional area. These forms also permit the use of junction plates, by means of which the structure may be assembled and united into a continuous whole, and the extended surface permits a better contact and adhesion of the concrete. This system has been extensively employed in France for floors and for arched coverings. In practice the edges of the flanges are marked with slight nicks at regular intervals, each bar thus forming a measuring rod, enabling the structure to be erected rapidly and accurately, the position of each piece being readily indicated. For any light structure, such as a tank, for example, it is a simple matter to mark off the members in the shop, and send them to be erected at a distance. Upon arrival the erection can be accomplished by the insertion of a few bolts, the work being performed by ordinary labourers under the direction of a skilled foreman.

When heavy loads are to be supported, M. Bonna uses sections of 30 by 30 millimetres and of 40 by 40 millimetres, of various thicknesses. The usual arrangement is to make tubular beams of four angle-irons, joined by flat plates, or to construct beams of sinusoidal form, using the cross-shaped sections. These beams are placed so as to sustain the principal loads, even before the imbedding concrete is added. The maximum bending moment and the maximum shearing efforts are transmitted to the extremities of these beams in such a manner that the shearing efforts are resisted by the accessory reinforcements.

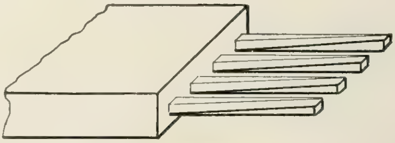


FIG. 5. REINFORCEMENT, RANSOM SYSTEM.

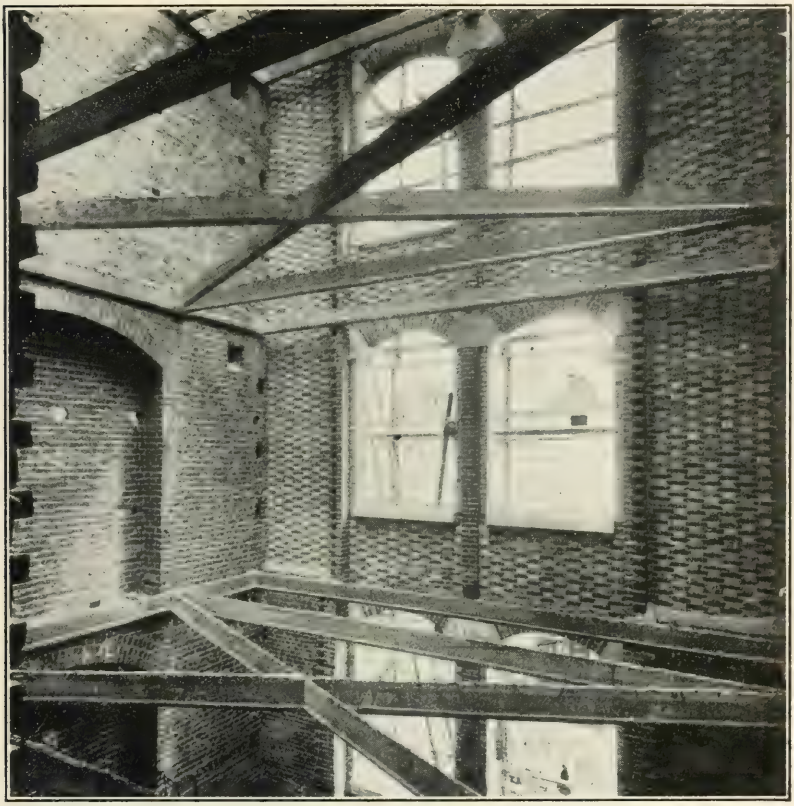


FIG. 6. SPINE-REINFORCEMENT FOR THE FLOORS OF A BUILDING, COTTANCIN SYSTEM.

The Bordenave system closely resembles that of Monier. The distinguishing feature is that the reinforcing rods are neither round nor square in section, but are of the I, U, or L shape.

In Austria the Melan system is much used, especially for the construction of arches and floors. In this system the arch is composed of I beams imbedded in the concrete, the profile being determined by the centering and abutting against the floor joists when used for floor construction. This arrangement presents much similarity to the Ransom system, except that in the latter the reinforcement consists of stout rods of square section, twisted so as to prevent any possible slipping in the mass of concrete. (Figure 5.) At first sight this method seems inferior to those in which the metal and the concrete are freer to play their respective parts in resisting the stresses. There appears also a disadvantage in the absence of connecting members between the rods.

The Hyatt system uses the metallic reinforcement in the form of flat plates, placed vertically and pierced with openings through which round connecting rods are passed.

The system of the Expanded Metal Company is peculiar mainly in that it employs the well-known expanded metal as the material for the reinforcement of the concrete. This material, which is made by slitting sheet metal and drawing it out, possesses the advantage of being entirely in one piece for great lengths, and not composed of many separate wires as an ordinary wire netting must be. It is applicable not only to floors, ceilings, and similar work, but to arches, and general engineering construction.

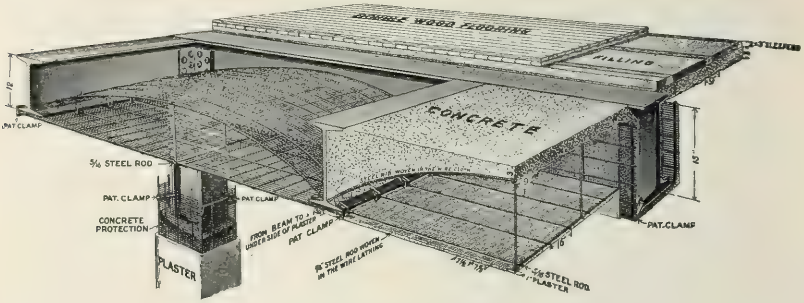


FIG. 7. THE ROEBLING FIREPROOFING SYSTEM.

The Roebling system of fireproofing construction, which is extensively used in the United States, is mainly employed for floors of steel-skeleton buildings. The fundamental principle consists in the use of arches of round rods and of wire network, these arches being sprung from beam to beam and resting on top of the bottom flanges of the beams. The rise of the arches is somewhat less than the depth of the floor beams, so that when the whole space, including the spandrels, is filled with concrete up to the level of the top flanges, the reinforcing arches are entirely imbedded in the concrete. The arches of rods and wire netting are strong enough to bear considerable weight without the concrete, and when the whole is completed it makes a solid and satisfactory construction. The details are well shown in the illustration.

Having thus mentioned the principal systems we may proceed to examine different examples of construction in each of them.

Floors and Ceilings.—M. Cottancin employs a system of beams which he calls "spine-reinforcement" *(épines-contreforts)*. (Figure 6.) This system employs beams of concrete formed about a metallic skeleton and placed on edge to obtain the maximum resistance to bending. The wires of these beams are interwoven and secured to

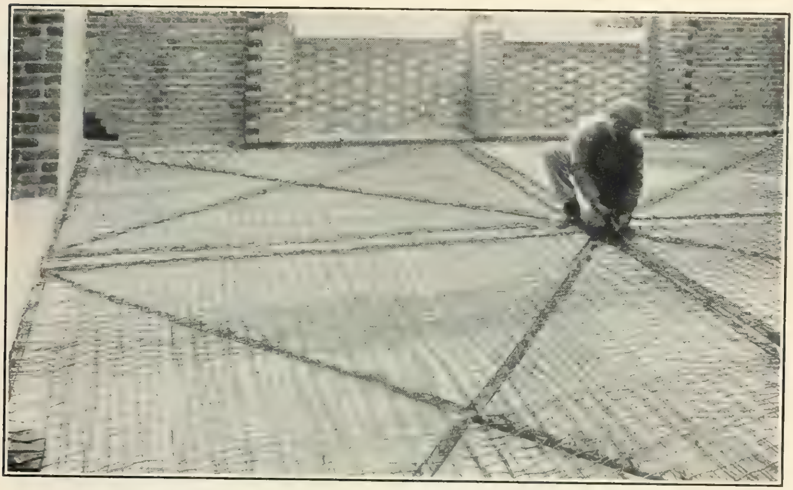


FIG. 8. TYING THE HORIZONTAL NETWORK TO THE SPINE-REINFORCEMENT, COTTANCIN SYSTEM.

those of the horizontal network both above and below, in order to secure the greatest rigidity. (Figure 8.) Theoretically this arrangement may be considered as a sort of lattice, as A B C D, Figure 10, with its upper and lower chords connected by flat diagonals crossing without interruption. The verticals, *A* and *B*, acting in compression, are replaced by the mass of concrete, while the verticals *A'* and *B'*, acting in tension, are replaced by the wires of the skeleton. Tests

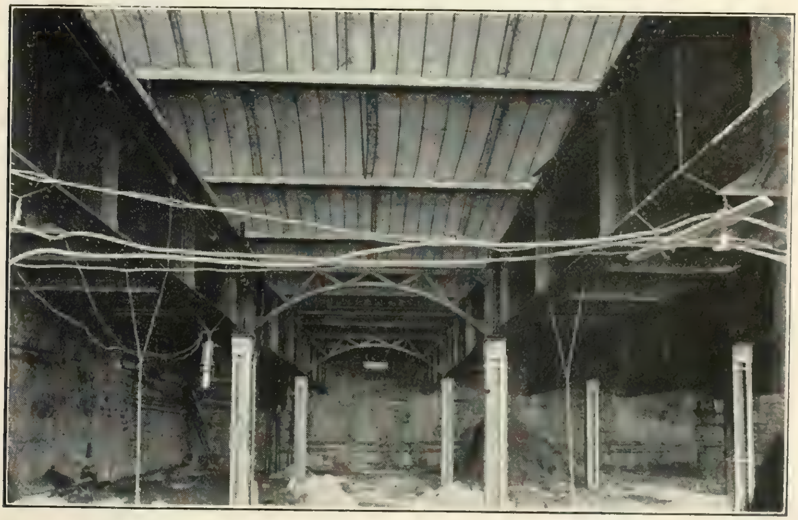


FIG. 9. ROEBLING SYSTEM OF FIREPROOFING. VIEW TAKEN UNDER CANADIAN PACIFIC TRAIN SHED, MONTREAL.

made in the laboratory of the Ponts et Chaussées de France have demonstrated that floors of this construction are of ample strength when the spaces do not exceed 1.30 metres, if wires 4 millimetres thick are used and the total thickness of the mass is 4 centimetres. The intersections of the beams are arranged so that the surfaces are smooth and flat, care being taken in all cases to place the supports according to the disposition of the loads. It is altogether possible at the same time to place the points of support to meet the artistic requirements of the architect. M. A. de Baudot, who has made extensive use of the Cottancin system, has found it especially adapted to meet the artistic and structural requirements of modern ornamental architecture.

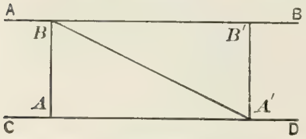


FIG. 10. DIAGRAM OF A LATTICE GIRDER, COTTANCIN SYSTEM.

As regards the ceilings, the crossed arrangement of the beams permits the employment of very artistic effects. The method employed by M. Cottancin is to provide the beams with lower flanges, C and D, Figure 11. These are intended to support the light slabs of reinforced concrete which form the ceiling. During the construction these slabs are held up against the under side of the floor by small props, in the position A, B, and when the concrete has set they are permitted to drop to the position C, D. This operation is clearly shown in the photographs, Figures 12, 13, and indicates the manner in which the use of expensive scaffolding is avoided.

The characteristic feature of the Hennebique system lies in the construction of the beams. These are rectangular prisms of cement-concrete with rods of iron or steel imbedded in the lower portion, these latter being tied in to the rest of the beam by stirrups of iron. A later improvement consists in the addition of a second set of rods placed parallel to and beneath the first set, in the same vertical plane. This second set of rods performs a double function. First, they form, in connection with the first set and the stirrups, rigid triangles of which the shearing resistance increases as the point of support is reached, where this effort is a maximum; second, these reinforcing members follow exactly the path of the bending effort of a continuous girder of several spans, permitting the application of the corresponding methods of computation.

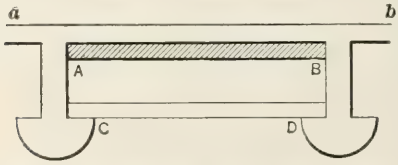


FIG. 11. FLANGES OF SUPPORTING BEAMS, COTTANCIN SYSTEM.

Thus it will be seen that M. Hennebique has succeeded in con-

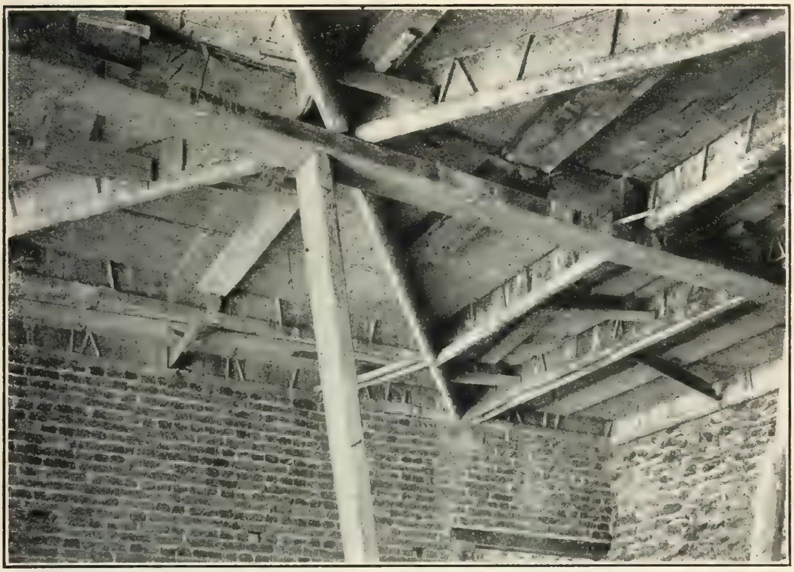


FIG. 12. SLABS OF REINFORCED CEMENT SUPPORTED ON THE FLANGES OF THE SPINE-REINFORCEMENT TO FORM A SCAFFOLDING.

structing a homogeneous beam composed of heterogeneous materials, forming a single structure of united parts, and giving a high degree of resistance. The main girders are reinforced with several sets of rods and may be given any desired form. (Figure 14.) Such girders

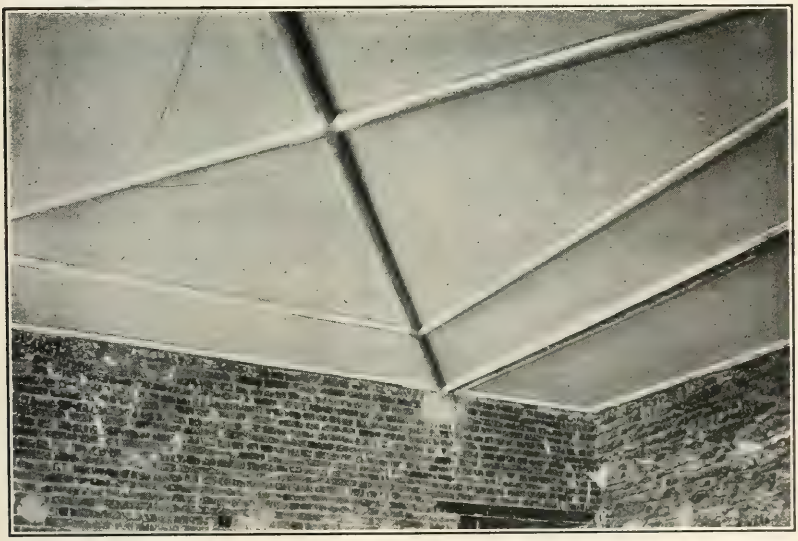


FIG. 13. SLABS OF CEMENT LET DOWN, FORMING A CEILING, COTTANCIN SYSTEM.

are constructed to sustain loads of 5,000 to 10,000 kilogrammes per superficial metre. The secondary beams (*a*, Figure 15,) which are united with the main beams, are reinforced by two or four rods and are capable of sustaining 2,000 to 3,000 kilogrammes per square metre. Finally the arched filling *b*, between the secondary beams, which is also reinforced with light rods and stirrups, is capable of resisting a load of 200 to 3,000 kilogrammes per running metre. This filling constitutes a continuous flooring independently of the beams, and is capable alone of spanning the spaces usually occurring in residences and similar buildings. For large public buildings and industrial establishments, however, it is necessary to use beams of reinforced concrete to span the large openings and support heavy loads without intermediate supports.

In the Hennebique system it is usual to mould the concrete entirely in place. For this purpose there is erected a scaffolding of the shape of the beams and arched filling. Sometimes, however, it is practicable to use a system of separate floors and ceilings, in which case the various parts can be made elsewhere and assembled in place; but in all instances the beams are constructed in place.

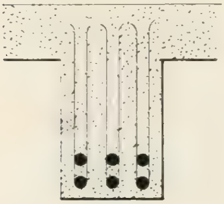


FIG. 14. MAIN GIRDER, HENNEBIQUE SYSTEM.

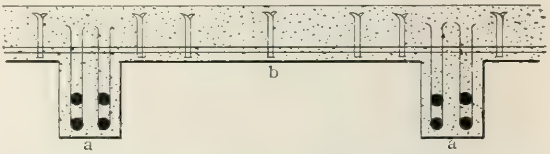


FIG. 15. a a, SECONDARY GIRDERS; b, CEILING FILLING; HENNEBIQUE SYSTEM.

Walls and Partitions:—The question of the construction of walls and partitions has been ingeniously solved by M. Cottancin. Concrete itself is not altogether suitable for vertical partitions, since the softness of the fresh material and the difference in density between the cement and the sand prevent the construction of a thoroughly homogeneous mass. M. Cottancin therefore employs hollow bricks in connection with the metallic reinforcement. (Figure 16.) The reinforcing rods pass through the vertical openings in the hollow bricks, as well as between the horizontal joints, the two systems of rods being interwoven with each other. If the partition is required to be very strong, it is composed entirely of bricks, with spine reinforcement, while for light dividing walls a limited number of bricks may be used, the intervals being filled in with blocks of plaster or concrete. M. Cottancin has erected the façades of houses 5 or 6 storeys in height by using double walls of bricks 5 centimetres thick, reinforced with the spine construction already described for floors. M. Monier constructs partitions upon a skeleton which is interwoven with those of the floor beneath and the beam overhead, when the location permits. Under such conditions the partition forms a sort of deep lattice girder, adding materially to the strength of the floor. M. Wayss has proposed to give the horizontal reinforcement rods of the partition a slight degree of curvature. (Figure 17.) This distributes the load over a greater portion of the reinforcing metal of the floor beneath. These horizontal rods are permitted to enter a certain depth into the floor and ceiling, in order to secure a more complete union between the various parts of the construction. The partition is completed by placing temporary board partitions each side of the reinforcement, and filling the space with concrete. Especial care should be taken in this operation to insure that the concrete penetrates between the interstices of the network. Some constructors prefer to use but one temporary board partition, applying the concrete upon and through the network from the other side, and watching to avoid the formation of gaps or voids. By using concrete of moderate consistency this can be effectively done with the trowel. The metallic reinforcement is in all cases secured to the wall masonry by loops or other suitable fastenings.

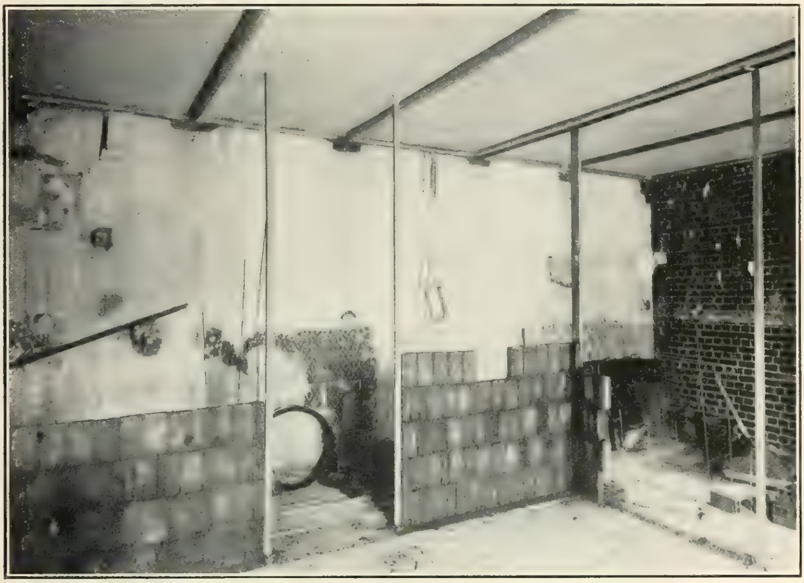


FIG. 16. PARTITIONS OF BRICK AND REINFORCED CONCRETE, COTTANCIN SYSTEM.

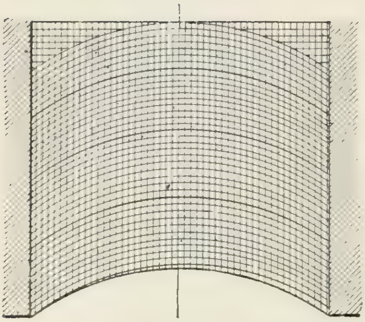


FIG. 17. PARTITION REINFORCEMENT, WAYSS SYSTEM.

In the Hennebique system the partitions are from 8 to 12 centimetres in thickness. These are moulded between boards. The vertical rods are placed in position, and the wall is filled up on one side. The horizontal rods are then placed in position, and the filling of concrete completed. (Figure 18.) Three arrangements are practicable, according to circumstances. When there is a vertical load it is important to prevent bulging, and the vertical rods are arranged alternately near each side of the wall, the stirrup-irons being placed so as to add to the strength of the mass. When a pressure from one side is to be resisted, the vertical rods are placed near the opposite side, the strength being made proportional to the estimated pressure at each portion. For partitions which may be subjected to pressure from either side, the forces are computed separately and the rode on each side are made strong enough to resist the alternate pressures.

Roof Construction:—The various methods of employing reinforced concrete present numerous advantages for roof construction. The old design of Mansard roof is very hot in summer and cold in winter, while the use of a double wall of reinforced concrete, such as that of the Cottancin system, renders this portion of a house habitable. In like manner the use of arched-roof construction in reinforced concrete enables wide spans to be covered in industrial buildings or halls and meeting places. Dormer windows or skylights can be constructed in such roofs, forming a portion of the complete structure without weakening the whole, and at the same time affording excellent opportunities for decoration and ornament. The entire complication of frameworks or truss construction is eliminated, so that a roof of the Mansard type can be built of large spans in reinforced concrete, especially if double ceilings are employed with connecting reinforcement, this constituting

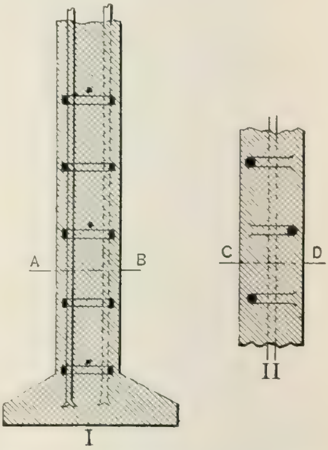


FIG. 18. PARTITION WALL, HENNEBIQUE SYSTEM.
I, section on CD. II, section on AB.

a series of lattice beams as A B, D C, E F, Figure 19. Light rafters can then be placed upon these supports, carrying a roofing of zinc, and the circulation of air thus permitted makes the space beneath cool, while the rooms below are protected by the solid ceiling K E, of reinforced concrete.

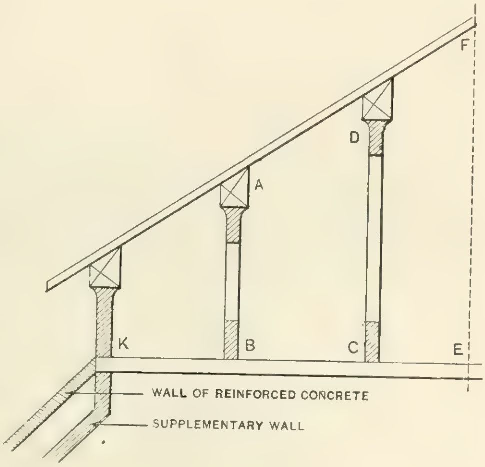


FIG. 19. ROOF, COTTANCIN SYSTEM.

It is entirely practicable to leave the concrete ceiling visible, but where an artistic finish is desired this construction lends itself admirably to ornamentation in ceramics or colored glass, or it may be plastered and tinted.

In the application of the Monier system to roof construction the rafters and purlins are replaced by slabs of reinforced concrete which replace the usual frames. These are used for wide spans, the horizontal thrust upon the walls being taken up by suitable tie-rods. The other systems present no peculiarities in their applications to roofs.

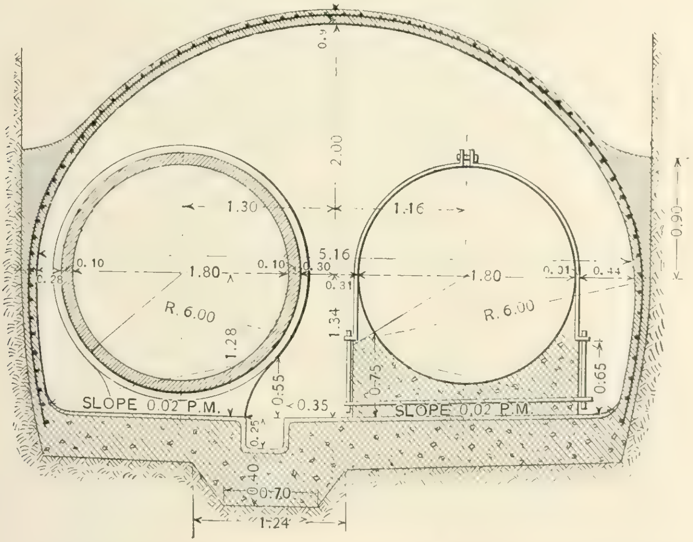


FIG. 20. REINFORCED-CONCRETE TUNNEL BUILT BY M. BONNA FOR CARRYING THE ACHÈRES SEWERS.

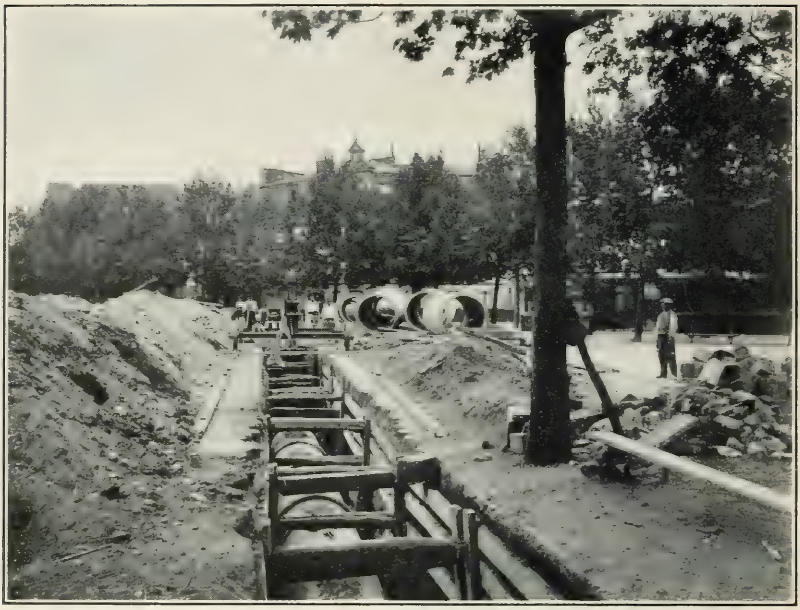


FIG. 21. LAYING REINFORCED-CONCRETE DRAIN, BONNA SYSTEM.

Arches and Tunnels:—The construction of tunnels is naturally somewhat similar to that of pipes, but the section is usually elliptical or three-centred. In the construction of the drainage works for the city of Paris at Achères M. Bonna has employed a depressed arch. The tunnel, Figure 20, is elliptical in section, 5.16 metres in width and 3.34 metres high. The total length is 2.5 kilometres and it contains two mains of 1.80 metres in diameter. The skeleton is composed of a lattice of rods spaced 11 centimetres apart, one set following the elliptical curve of the arch, the other being longitudinal. The rods are of round steel 15 and 18 millimetres in diameter respectively, and are united at the intersections by iron wire. The whole is imbedded in a mass of concrete 8 centimetres in thickness. When it was desired to render any portion of the tunnel water-tight, a thin sheet of lead was placed over the first layer of concrete and held in place by light iron hoops, the full layer of concrete being then applied.

Arches of various forms are constructed in the same manner as floors. Since they may be made much thinner than when built of bricks or masonry, they are very useful when the head room is contracted. Arches of reinforced concrete have also been found very valuable in military engineering, in connection with fortification work, involving a maximum resistance for the mass employed.

THE ECONOMY OF ISOLATED ELECTRIC PLANTS.

By Isaac D. Parsons.

The active interest of an actual cost comparison between isolated-plant and central-station electricity supply needs no enforcement beyond that given in Mr. Parsons' opening paragraph. The striking point is that a thorough investigation of more than two hundred and fifty isolated plants discovered only seventeen in which cost records were full and reliable. The following article therefore represents a remarkable concentration of valuable figures—the most interesting compilation of exact data in this field we have yet seen.—The Editors.

THE relative economy of generating electricity in an isolated plant and of obtaining it from a central station has for some time been an undecided question. The rapid increase—especially in the large cities of the United States—in the number of immense buildings, including hotels, office buildings, and apartment houses, lighted entirely by electricity and in which the elevators and ventilating fans are operated from the same source, makes the solution of this question to-day a consideration of great importance. The universal employment of steam for heating and the growing number of refrigerating machines in use rendering the installation of a steam plant necessary, as well as the increasing size of the buildings, tend to encourage the introduction of the isolated plant and to increase its economy. At the same time, the conditions prevailing in some buildings, such as clubs, apartment houses, and hotels, where freedom from noise and vibration is a prime requisite, may tend to discourage its introduction and lead to the adoption of the central-station supply.

The following investigation was undertaken by the writer and Mr. Arnold von Schrenk in an attempt to ascertain which of the two methods is the more economical in six classes of buildings in New York, and to determine as nearly as possible those conditions, either inherent in a class of buildings or due to peculiarities of installation or management which materially influence the economy. The six classes referred to are:—Office buildings, loft buildings, department stores, apartment houses, hotels, and clubs, and over two hundred and fifty buildings were visited in the effort to obtain reliable figures and to ascertain the various conditions of operation. Of this number seventeen only were found where information could be obtained which was reliable in every particular, and only these will be considered in detail, as the great variation in conditions even among similar buildings of the same class renders incomplete statistics of very doubtful value.

The figures as to electrical output of each of these plants were obtained from wattmeter readings or from hourly ammeter readings and were verified by personal observation of the instruments from which they were obtained, and were also checked by comparison with other buildings were similar conditions exist. In some cases, tests were made of the instruments to determine their accuracy. The figures recorded as the output of a plant are in every case the total number of kilowatt hours supplied at the switchboard and used as light or power, and where a storage battery was installed its output only was considered. The expenses of the plants were divided into those of labor, gas, central-station auxiliary or breakdown service, coal, water, ash cartage, oil and waste, repairs, incandescent lamps and arc-lamp carbons, interest, depreciation, and sundry supplies not included in the foregoing. Figures concerning these items were obtained in most cases directly from the books of the chief engineer or owner, and may be considered within very small limits absolutely accurate. Under the item labor are included the wages of all the engineers, firemen, oilers, and coal passers employed in the plant, excepting in a few cases where extra employees were required by a large refrigerating machine or similar apparatus. In these cases the wages of the extra men were deducted from the total. If it were determined what employees could be dispensed with were the plant not installed, and the wages of these men only were taken, it would give the true cost of labor chargeable against the plant. To decide this, however, was in most instances a rather uncertain and difficult problem and it was thought fairer to include in the expenses the wages of all the employees, which, with the other items, give the total cost of running the building with a plant. Then by adding to the expenses of the central-station service the cost of the labor necessary for heating, elevator supervision, etc., the total cost of running under the conditions of central-station supply can be found. The difference between the two results is the true amount gained or lost by the installation of the plant.

The item coal includes that which is burned to generate the steam used for the engines driving the generators, for the feed pumps, and in most cases that used for the house pump and whatever live steam is used in heating the building. In many buildings, refrigerating machines, steam laundries, steam cooking apparatus, or pumps, received steam from the same boilers as the engines driving the dynamos; but in such instances figures from recent tests were available by which the amount of coal used for these purposes could be determined.

With the central-station supply either a boiler or a connection with the street mains is required to obtain the steam necessary for heating the building, as well as for the hot-water supply and for running the house pump, unless it is operated electrically. To determine what extra sum must be added to the actual cost of current in order to find the total expense of running the building from the central station, figures were obtained from two large loft buildings, an office building, and six apartment houses and hotels using steam for heating and for house pumps only, from which the cost of coal, labor, and water required for these purposes could be calculated. The expenses for coal were reduced to dollars per 1,000 cubic feet heated, and showed practically constant factors, irrespective of the shape or size of the building, of $1.10 per 1,000 cubic feet for apartment houses, 90 cents per 1,000 cubic feet for office buildings, and 40 cents per 1,000 cubic feet for loft buildings. The cost of labor, which includes the wages of the firemen and the expense of elevator supervision, has to be determined in each particular case, but usually amounts to a sum about equal to the cost of coal.

Interest was calculated in all cases at 5 per cent. on the principal invested in the plant. Depreciation on dynamos, engines, and switchboards of 5 per cent., and on boilers, pumps, and steam piping of 8 per cent., was considered liberal; and since, as a rule, the cost of the dynamos, engines, and switchboards approximates two-thirds of the total cost of installation, and that of the boilers, pumps, and steam piping one-third, a uniform rate of $10/3 + 8/3$, or 6, per cent. was charged against the whole plant. If 5 per cent. of the original capital invested in the engines is set aside each year as a sinking fund, this sum will accumulate interest at 5 per cent. and at the end of fourteen and one-half years the total of the amounts reserved, with compound interest, will equal the original cost of the engines; so that 5 per cent. depreciation assumes a life of but fourteen and one-half years. Similarly 8 per cent. depreciation on boilers assumes a life of ten years. As a matter of fact, both of these periods are much exceeded in first-class modern installations. On storage batteries, where depreciation is a somewhat doubtful quantity, it was taken as 10 per cent., which assumes a life of but seven years. The load factor in every case was calculated for the hours the plant was in actual operation.

As regards load and other conditions of operation, all the buildings

All buildings heated by steam. All engines non-condensing and direct-connected to the generators.

Building number	1	2	3		4	5	6	7	8
Type of building	Office	Office	Office		Office	Office	Loft	Loft	Loft
Number of floors	11	over 20	13		15	12	12	12	10
Ground plan	50x120	70x100	60x150		75x100	40x100	200x176	100x100	40x200
Number of electric elevators	4-25 h.p.	10-25 h.p.	6-27 h.p.		8-30 h.p.	3-20 h.p.	15-20 h.p.	4-20 h.p.	4-25 h.p.
Part of building lighted	All	All	All		All	6 floors	All	All	All
Type of engine	Simple	Comp'd	Comp'd		Simple	Simple	Simple	Simple	Simple
Number of generators	4	4	5		3	1	3	3	3
Total capacity of generators, kilow	260	575	475		300	40	300	260	90
Average load on generators	.55	.75	.75		.90	.65	.90	.75	.60
Voltage	220&240	120	115&240		116	240	240	240	240
Type of boiler	H. Tub.	W. Tub.	Water Tube		H. Tub.	H. Tub.	H. Tub.	W.Tub.	H. Tub.
Boiler pressure	90	125	115		100	95	90	100	100
Back pressure	0	0	1 to 3		4	1 to 5	3 to 9	2 to 5	7 to 10
Kind of coal	Pea	Buck.	Buck.		Pea	Buck.	Rice	Buck.	Buck.
Capacity storage battery, amp, hrs	....	3500	....		3000	300	....	....	....
Load factor of lighting load	.24	.43	.72		....	.87	.70	.45	....

Cost of light, heat and power with plant installed.

	1	2	3		4	5	6	7	8
Time covered by figures	1 year	1 year	9 mos.	1 year	1 year	1 year	1 year	1 year	1 year
Labor	$2,460	$7,228	$6,750	$9,000	$6,318	$1,484	$4,628	$4,776	$1,662
Coal and removal of ashes	2,758	10,070	7,663	10,238	9,174	1,012	4,192	2,736	2,129
Water	254	776	756	1,004	900	97	446	204	270
Oil and waste	181	287	171	215	128	103	193	108	80
Lamps	120	600	338	450	420	44	233	33	57
Repairs and sundries	183	50	429	568	65	295	100	108	478
Interest and depreciation	1,340	10,420	3,630	4,840	5,365	1,274	2,200	2,730	908
Central station service	1,370					225		300	579
Total	$8,666	$29,431	$19,737	$26,315	$22,370	$4,534	$11,992	$10,995	$6,163
Output—light K. W. hours	91,804	409,233	395,949	550,000		18,123			
" —power K. W. "	59,760	266,344	160,963	225,000		48,437			
" —total K. W. "	151,564	677,577	556,912	775,000	721,301	66,560	379,939	143,320	130,000
Cost per K. W. hour	$0.057	$0.044	$0.034	$0.034	$0.031	$0.068	$0.032	$0.077	$0.047
Tons of coal consumed	919	3007	2250	3012	2619	337	1873	863	835
Lbs. coal per K. W. hour	15.5	10.0	9.1	....	8.2	11.4	11	13.5	14.4

Probable cost of light, heat and power for same period if no plant installed.

	1	2	3		4	5	6	7	8
Central-station bill	$12,374	$28,000	$22,300	$31,000	$29,500	$5,307			$6,500
Labor	1,000	3,600	2,700	3,650	3,600	1,136	$1,840	$1,740	1,600
Coal	660	1,800	700	1,070	1,080	877	920	765	
Total	$14,034	$33,400	$25,700	$35,720	$34,180	$7,320			$8,100

TABLE I. DATA OF ISOLATED PLANTS.

can be divided into two classes—those used for business purposes, such as office and loft buildings and stores, and those which are used for residential purposes—such as hotels, apartment houses, and clubs. In the former class, a small uniform lighting load during most of the day is succeeded at about 3 p. m. by a heavy load lasting but a few hours, which after 7 p. m. again becomes very small. In the latter class the heavy load, instead of falling off in the evening, continues to 1 or 2 a. m., giving a more uniform load and a higher load factor. We will consider the business buildings first.

Building No. 1 is an office building having a large store on the ground floor. The dimensions of this building, as well as a general description of its plant, are given in Table 1. Very complete daily records are kept of all supplies and of the output. The kilowatt hours used for lighting are obtained from hourly ammeter readings, and the power required for the four electric elevators is calculated by multiplying the total number of minutes the elevators are in actual operation, which is recorded automatically by an instrument attached to each elevator, by the average kilowatts consumed per minute, found from previous tests. Steam is used only for the engines driving the dynamos and for small house and feed pumps. The generators are started at 8 a. m. and stopped at 8 p. m., current being obtained during the night from the central-station. The expenses of operating the plant and the electrical output for one year are shown in the table. The 19,293 kilowatt hours which were obtained from the central station are included in the above output. Were these kilowatt hours deducted from the output and $1,370, the amount paid for them, subtracted from the expenses, the cost per kilowatt hour would be reduced to $0.055. Calculated at prevailing wholesale rates, the total amount of electricity used in this building during the year, (151,564 kilowatt hours), would cost, if purchased from the central station, $12,373.78, with all discounts allowed for. With central-station service, heating the building and supervision of the elevators would necessitate the employment of one man for the whole year and another during the winter months, making the labor expenses about $1,000. Judging from similar buildings, coal for heating would amount to 220 tons, so that there would be a total expense for heating, etc., of $1,700 a year. This sum added to the above figure for central-station service brings the total cost of running the building under these circumstances to an amount which is $5,400 more than the cost of operating the plant.

The increased amount of coal burned in this building during the winter months, due to heating, is shown by the curve in Figure 4.

In the large office building (No. 3) for which a similar curve is given in this figure, the great volume of exhaust makes necessary the use of very little live steam for heating and consequently the coal burned per kilowatt hour is practically constant throughout the year. The curves of Figure 1 show the maximum and minimum demand for light in this building during the year.

Building No. 2 is one of the largest office buildings in New York and contains a little over 2,000,000 cubic feet. Tested wattmeters on both power and light circuits enable absolutely correct daily readings of the electrical output to be obtained and data of the expenses of operating the plant were procured from the books of the chief engineer and superintendent. The ten electric passenger elevators are in operation daily from 8 a. m. to 6 p. m. In addition to the quantity employed in the generation of electricity, steam is used for a 25-ton refrigerating machine, for a laundry, for steam cooking apparatus, and for several large pumps. The coal consumed to generate steam for these machines during the year 1900 was found by tests to be 989 tons, and since the coal consumption for the year for all purposes was 3,996 tons, 3,007 tons are chargeable to the electric plant and to heating. The employees are three engineers, four firemen, and three oilers, but since one fireman and one oiler would not be required were it not for the refrigerating machine, etc., mentioned above, the wages of these two men are not included in the expenses of operating the plant. The output and expenses for the year 1900 are given in Table 1. The cost per kilowatt hour, $0.044, is not very low for so large a plant working under such favorable conditions as to installation. Central-

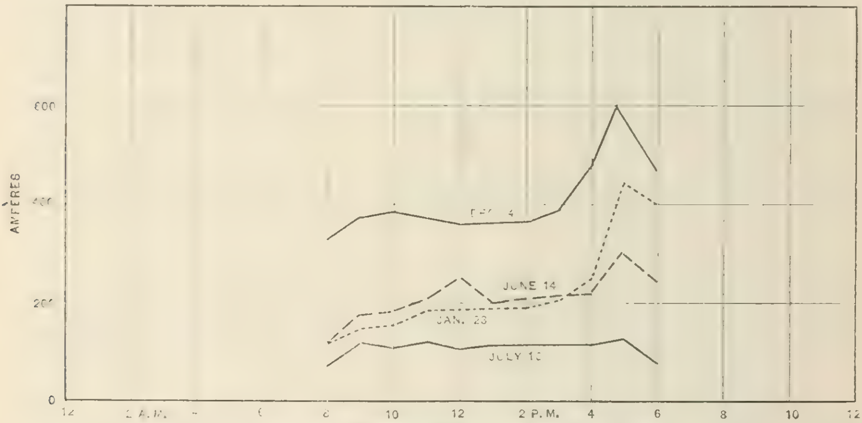


FIG. 1 MAXIMUM AND MINIMUM LIGHTING LOADS IN A SMALL OFFICE BUILDING (NO. 1) DURING THE SUMMER AND WINTER MONTHS

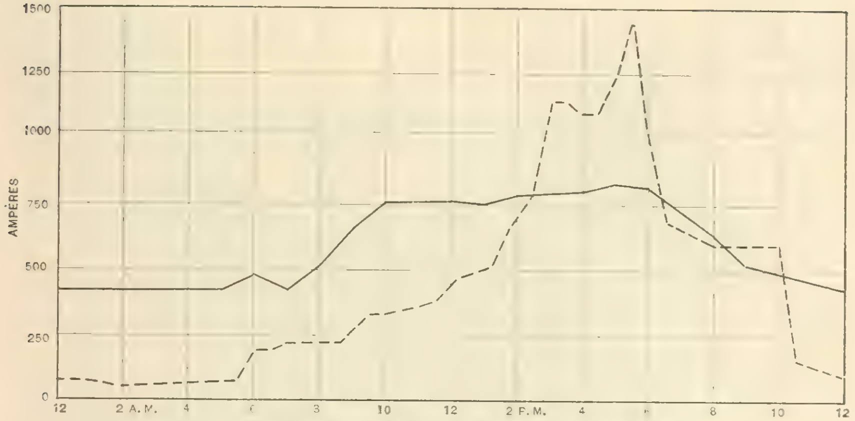


FIG. 2 LOAD CURVES OF OFFICE BUILDINGS NO. 2 AND NO. 3 FOR APRIL 27, 1901, A CLEAR DAY.

station rates for this enormous quantity of electricity, while they might not be quite so low as $0.044, would not be far above it and the gain by the isolated plant is, in this case, small. Figure 3 shows the change in average daily load from month to month and Figure 5 the great variation in the lighting load from day to day during three characteristic months. The variation of the power load is small.

Building No. 3 is an office building having about 60 per cent. of the cubic contents of building No. 2 Statistics of the lighting output were obtained from half-hourly ammeter readings and the power consumed by the elevators was accurately ascertained. In addition to the electrical machinery, several large pumps and three steam elevators are installed, and the amount of coal used by them was accurately determined during two weeks use of the central-station ser-

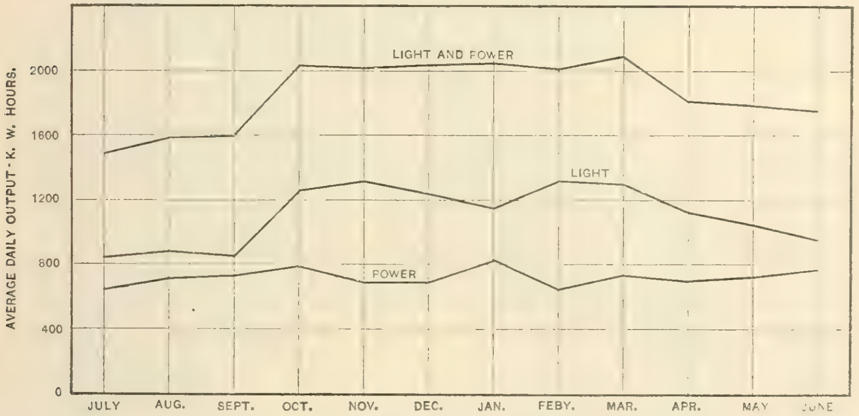


FIG. 3 VARIATION OF AVERAGE DAILY LOAD FROM MONTH TO MONTH IN LARGE OFFICE BUILDING (NO. 2)

vice. Figures of kilowatt-hours output unfortunately could be obtained for only nine months, from May to January, inclusive. During that period the total coal consumption was 3,003 tons, of which 74.9 per cent., or 2,250 tons, were chargeable against the electric plant. The expenses and output of the electric plant and the probable cost of heating the building and of elevator supervision for nine months are given in Table 1. The yearly expenses are also given, that they may be more easily compared with those of the other buildings.

The cost per kilowatt hour is far below the central-station rates and the use of this service would be out of the question since it would mean an increased annual expense of $9,000.

A comparison of the expense account of this and of the preceding building shows that, except for the item of interest and depreciation, they agree quite closely, so that in this item must lie the main reason for the difference in economy. For the dissimilarity of this item in the buildings in question there are two reasons:—

First, the lighting load in the smaller building is more favorable to the isolated plant than in the larger building, as may be seen by comparing the load diagrams in Figure 2. Building No. 2 has few dark offices and is little used at night, so that excepting for the high peak between 3 and 6 p. m. the lighting load is small and at night is carried by the storage battery. The high peak, however, necessitates the installation of generators of large aggregate capacity, most of which are very little used. In building No. 3 there are a number of dark offices and the business pursued on several floors requires the use of much light throughout the night. The lighting load is thus more uniform than in building No. 2, and though heavier can be handled with smaller generator capacity. Besides, the expensive storage battery is absent. The power load is fairly uniform during the day in both buildings and at night is practically zero.

Second, in the large building the generators and storage battery have a combined full-load capacity of 5,150 amperes, though the maximum load never reaches 3,200 amperes, while in the smaller building genarators with an aggregate capacity of less than 2,900 amperes carry a load the maximum value of which is about 2,500 amperes.

Building No. 4 is an office building very similar in size to building No. 3. Its many dark offices cause a very heavy and fairly uniform lighting load so that, as in building No. 3, the total kilowatt-hours output exceeds the output in building No. 2. The eight electric elevators are in operation daily from 9 a. m. to 6 p. m. The output of the electric plant was obtained from hourly ammeter readings and the figures of cost of operation were procured from the agent in charge of the building. Other than the feed pumps and the engines driving the generators, the only machines using steam were small pumps and steam cooking apparatus which use about 110 tons of coal yearly, an amount which was deducted from the total yearly coal supply of 2,729 tons, leaving 2,619 tons chargeable to heating and the generation of electricity. The expenses of operating the plant in the year 1900, as well as the probable cost of heating the building and of elevator supervision were no plant installed, are shown in Table 1. The cost per kilowatt hour is much below any rate the central station would offer and the gain in this building through the installation of the plant is probably $12,000 annually. A comparison of the expense accounts of the last three buildings shows clearly the advantage of the storage battery in reducing the cost of labor. In building No. 3, three full shifts of employees are required, since the generators are operated twenty-four hours a day, whereas two shifts only are necessary in the buildings where storage batteries are installed. In those buildings the generators are stopped from about 8 p. m. to 6 p. m. and the battery carries the load during that time.

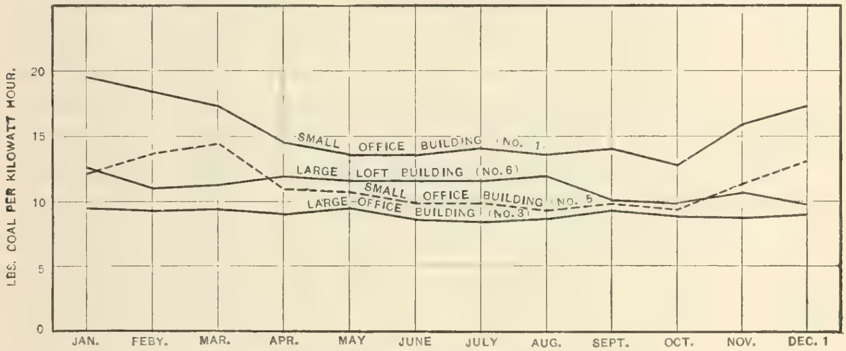


FIG. 4 MONTHLY VARIATION IN COAL PER KILOWATT HOUR IN OFFICE AND LOFT BUILDINGS.

Building No. 5 is a characteristic example of the modern small office building. Hourly ammeter readings enabled the output of both light and power to be calculated accurately. A very complete daily record of expenses also, including all items, was kept by the chief engineer. Coal in this building was used only for heating and for the generation of electricity. The great advantage of the storage battery is shown in this building, where if no battery were installed the elevators and lights would have to be supplied from separate machines to prevent fluctuations in voltage, which would require the installation of a 40-kilowatt machine for the elevators and a 20-kilowatt machine

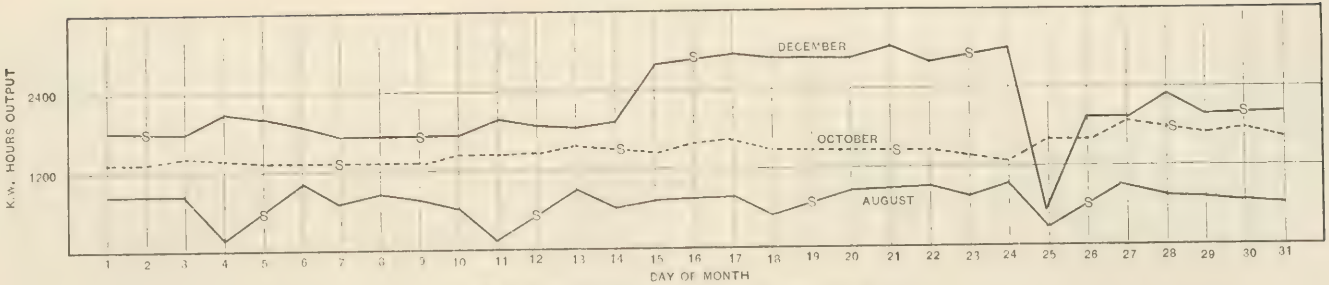


FIG. 6 VARIATION IN THE LIGHTING LOAD FROM DAY TO DAY IN A DEPARTMENT STORE (BUILDING NO. 9).

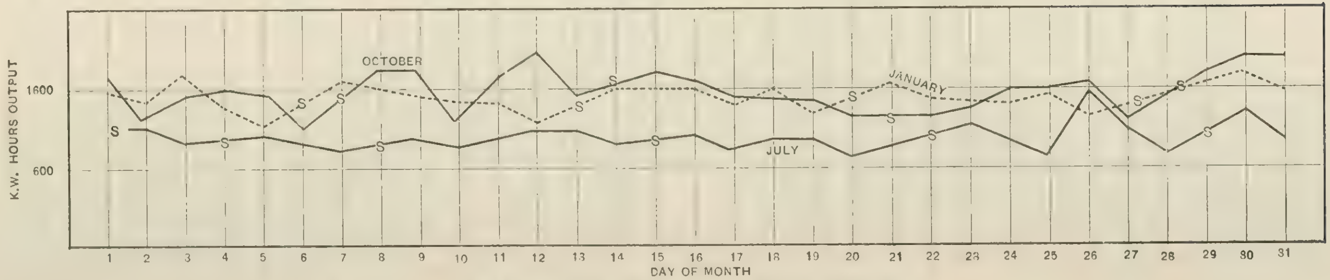


FIG. 5 VARIATION IN THE LIGHTING LOAD FROM DAY TO DAY IN A LARGE OFFICE BUILDING (BUILDING NO. 2).

S DENOTES WHERE DAYS OCCURED SUCH AS SUNDAYS AND HOLIDAYS, WHEN THE PLANT WAS NOT IN OPERATION.

for the lights. This would not only entail additional expense of installation, but neither machine would operate at an average load of more than half of its capacity. Moreover, if they were operated at night an increased cost of labor would result, and if they were not run at night the central-station bills would be higher than at present as the battery now carries the night load from about 8 p. m. to 6 a. m. The output and expenses of operating the plant are given in Table 1, as well as the expenses in addition to those of central-station services the year before the plant was installed. A comparison of the cost of running the building with and without the plant shows, with the same output, a balance in favor of the plant of nearly $2,700.

This concludes the data collected in regard to office buildings. As the five buildings cited include one of the largest office buildings in the city of New York, one of the smallest, and three buildings of average size, they cover the field fairly well. They indicate as a rule the marked superiority in economy of the isolated plant but, as shown in the case of building No. 2, a slight error in installation combined with unfavorable load conditions may, even in the very largest buildings, render the isolated plant of doubtful economy.

The next class of buildings to be considered is the loft buildings. In these buildings it is nearly impossible to decide what is the exact amount gained or lost by the installation of the isolated plant. Usually if the central-station service is employed, the owners of the building use a certain amount of the current for hall lights and for the elevators, if they are electric, and what electricity is used by the tenants for light and power is recorded on their wattmeters and paid for by them. The total amount of current is therefore split up into a number of separate items, each of which receives but a small discount, whereas the entire amount used in the building, taken as a whole, would be subject to a much larger discount. The difference between the amount which would be paid in the two cases increases, of course, with the number of tenants. Thus in a loft building of twelve floors where the total power consumed by the tenants is 9,000 horse-power hours per month, if each tenant occupied one floor and used on an average 750 horse-power hours (which is about the average amount used per tenant in this class of buildings) the rate would be $0.07 per horse-power hour. If, however, only three tenants occupied the entire building, each taking 3,000 horse-power hours per month, the rate would be reduced to $0.05 per horse-power hour. These conditions are very favorable to the isolated plant, especially when there are many tenants each using a small amount of electricity. Current can profitably be furnished to them at a discount from central-station rates. The current supplied to the two or three lower floors of loft buildings is used principally for lighting, whereas in the upper floors less light is necessary and much power is used for operating sewing machines, heating irons, etc. This tends to make the average load heavier than in the office building and enables a plant to be operated more efficiently on account of the high load factor.

Building No. 6 is a large loft building, having a plant in the subbasement which supplies the power for the motors on the upper floors and for fifteen electric elevators, as well as current for lighting the building. A patent forced-draught system enables a cheap grade of coal to be burned with much advantage in the way of economy. Very complete daily records enabled the cost of production to be determined with great accuracy. No steam was used excepting for the engines driving the dynamos, for the feed pumps, for a small house pump, and for heating. The plant is in operation from 6 a. m. to 10 p. m. daily excepting Sunday. The expenses and output for one year are given in Table 1. The extremely low cost per kilowatt hour is due partly to the cheap fuel and partly to the high load factor. If the central-station service were employed, not only would it be impossible to make any profit from selling current to the tenants, but power for the elevators would have to be paid for at $0.067 per kilowatt hour instead of less than $0.032, and $2,920 yearly would be expended for heating the building and for elevator supervision as shown in the table. In Figure 8 are given the maximum and minimum loads carried by the plant during the year and Figure 4 shows the variation from month to month of the coal burned per kilowatt hour. The fact that there is no increase during the winter months indicates that the building is heated without the consumption of any extra fuel.

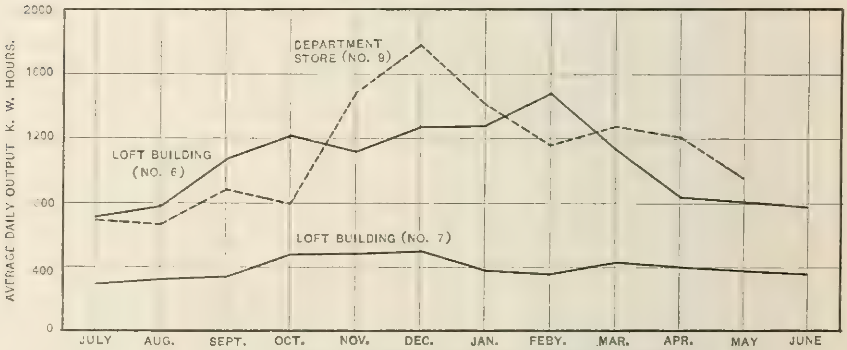


FIG. 7 VARIATION OF AVERAGE DAILY LOAD FROM MONTH TO MONTH IN LOFT BUILDINGS AND DEPARTMENT STORE.

Building No. 7 is used partly for lofts and partly for offices, only the six upper floors being used for manufacturing purposes. As in nearly all buildings of this class the wiring throughout is for the 240-volt two-wire system. The use of a potential regulator acting on the fields of the dynamos enables the same generator to be used successfully for both elevators and lights simultaneously. No machinery using steam was installed other than that ordinarily included in the electric plant. The generators are operated from 7 a. m. until 8:30 p. m., the building being lighted during the night by the central-station supply. Electricity for power and light is sold to the tenants at central-station rates. Figures concerning daily output were obtained from wattmeter readings, and the expenses were procured from the superintendent's books. For one year the expenses and output were as shown in Table 1. It will be noticed that both the labor and interest and depreciation items are large, the latter being due to the installation of an extra 100-kilowatt generator which makes the full-load capacity of the plant 1,000 amperes at 240 volts, though the maximum load never reaches 600 amperes. The variation from month to month of the average daily load in this building and in building No. 6 is shown in Figure 7. The sum received annually from the tenants amounts to about $7,500. This subtracted from $10,995 leaves $3,445, which is the actual cost to the owners of running the building under present conditions. Were the central-station service used entirely, the expenses of running the building would be approximately as follows:

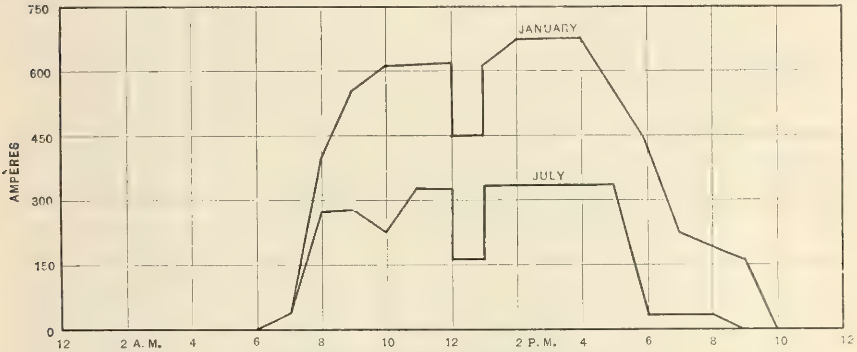


FIG. 8 MAXIMUM AND MINIMUM LOADS DURING THE YEAR
LIGHT AND POWER COMBINED, IN A LARGE LOFT BUILDING. (NO. 6)

Current for elevators at $0.05 per horse-power hour	$1,156
Current for hall and engine room lights	1,200
Coal for heating—225 tons	765
Labor: Engineer, 12 months, one fireman 12 months, one fireman 6 months	1,740
	$4,861

Building No. 8 is a loft building smaller than either of the preceding. Its plant furnishes current for the four electric elevators, for the various motors throughout the building, and for lighting. Electricity is supplied to the tenants at fixed rates during the time the plant is in operation (6 a. m. to 6 p. m.), but during the remainder of the twenty-four hours each tenant is supplied from the central station. Steam is used for the generation of electricity and for heating. The kilowatts output was obtained from ammeter readings, and the expenses from daily records. The expenses and output for one year are given in Table 1. The smaller cost of operation of the plant in building No. 8, as compared with No. 7, is due largely to the small labor item. Besides, in building No. 8 there are no spare dynamos, a fact which, though a disadvantage in case of accident to one of the machines, reduces the interest and depreciation charge to two-fifths of that in the preceding building. For 130,000 kilowatt hours yearly the central-station rate would not be below $0.05 per kilowatt hour, which would mean a saving by the isolated plant of $390 a year. The year previous to the installation of the plant the cost of heating the building and of elevator supervision was $1,600, which added to $390 makes a total saving by operating the plant of $1,990.

From the figures in regard to these three loft buildings it would seem that the installation of a plant in a building of this class and the sale of current to the tenants at central-station rates or, in very large loft buildings, at 10 per cent. to 25 per cent. reduction from those rates, would in most cases prove very profitable.

The department stores are the third class of buildings to be treated. Figures could have been obtained from several buildings of this class but the complications were such that in only one building were really accurate data of the cost of generating electricity available. Since the department store is however a special and limited class of building, one typical example is perhaps sufficient.

In most buildings of this class the uses of steam are almost as varied and numerous as they would be in a large town. Ice machines, steam laundries, steam cooking apparatus of many kinds, steam dish-washers, distilling apparatus, pumps of all sizes and varieties, blower engines and various other machinery, were found in almost every case and to determine the exact amount of steam used for these purposes was next to impossible. The steam used thus, furthermore, could not be ignored as it often formed nearly one-half of the total generated.

In the building which we will call No. 9, a steam laundry, steam cooking apparatus, one steam elevator, five hydraulic elevators, and a

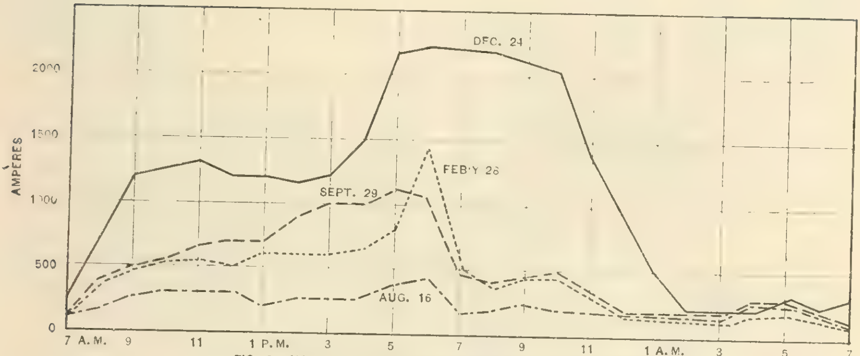


FIG. 9 MAXIMUM AND MINIMUM LIGHTING LOADS IN A DEPARTMENT STORE DURING THE SUMMER MONTHS.

large blower engine in addition to the electric plant received steam from the boilers. The electric plant had, however, been but recently installed and the amount of coal burned before its installation, when otherwise almost exactly similar conditions existed, could be obtained. This, with a knowledge of the amount of labor employed before the installation of the electric plant, enabled the extra cost entailed by its operation to be determined.

Building No. 9 is 5 stories in height and approximately 200 by 200 feet in ground plan. The plant consists of three generators having an aggregate full-load capacity of 2,400 amperes at 120 volts, direct-connected to simple engines. Steam is furnished for the electric plant and other purposes by horizontal tubular boilers rated collectively at 600 horse power. Buckwheat coal is used and the average pressure is 90 pounds. The dynamos are run usually throughout the twenty-four hours, and are only stopped on Sundays and holidays.

The output which is used for lighting only was calculated from hourly ammeter readings. The expenses of operating the plant were obtained from the chief engineer's books, and figures concerning the expenses the year before the electric plant was installed were procured from the books of the firm. The load on the dynamos averages during the twenty-four hours about 75 per cent. of their capacity, and the load factor varies between a maximum of .70 in July and August and a minimum of .30 in October, November, and January, the average for the year being about .56. This is higher than in most office and loft buildings, which fact is due to the comparatively large amount of light used during the day for decorative purposes in the department store, and to a load of about 225 amperes continuing throughout the night.

Figures, unfortunately, were available for seven months of the year only, from August to February inclusive, but as these include the months having both the heaviest and the lightest loads they are fairly representative of the yearly average.

Table 3 shows the operating expenses during seven months of the year, before the installation of the electric plant, and also during the same seven months of 1900 when the electric plant was in operation.

	Before plant installed.	After plant installed.	Difference.
Labor	$2285	$3822	$1537
Coal	2227	5436	3209
Water	200	488	288
Oil and waste	100	236	136
Lamps	——	171	171
Repairs and sundries	——	86	86
Int. and depreciation	——	2440	2440
Total	$4812	$12,679	$7867

TABLE 3. EXPENSES FOR 7 MONTHS—BUILDING NO. 9.

The output during the seven months of 1900 was 244,259 kilowatt hours which makes the average cost per kilowatt hour $0.032. This cost does not include the expense of heating, which is allowed for in the coal deducted from the total. The increase in the amount of coal used, due to heating, is, however, small, since the heating is done almost entirely by the exhaust. Were the electric plant alone installed the labor item would probably be $3,450, since only one man of the present force could be dispensed with. It we substitute this amount for $1,537, the expenses will be reduced to practically the same basis as in all the preceding buildings and the resulting cost per kilowatt hour is $0.036, which includes the cost of heating. The cost of 244,259 kilowatt hours if purchased from a central station would be about $11,000, which shows a very great advantage in the installation of the isolated plant, and with the two important points in its favor that the average load factor is quite high and that a steam plant is a necessity whether the electric plant is installed or not, there seems little doubt of the advisability of its installation in the department stores.

Figure 9 shows the maximum and minimum loads carried by the plant in building No. 9 during the year. The very heavy load on December 24 is due to the store being open in the evening, and to the use of many extra lights. The variation of the average daily load from month to month is shown in Figure 7, and the difference in load from day to day for three characteristic months in Figure 6.

Nearly all the "business buildings" of New York would, as far as load conditions are concerned, come within one of the three classes which have been discussed. The discussion of the buildings used for residential purposes will be taken up in the next article.

EDITORIAL COMMENT

MR. LONGMUIR'S thoughtful article, which leads this issue, is remarkable for its breadth of vision in surveying the industrial field—for the soundness of its philosophy in explaining industrial phenomena by sociological causes. In the individual and family ideals of the working community are to be found fundamental influences affecting national destiny. The nation, in war, or in manufacture and commerce, is what its workmen are capable of making it, and their capacity is in the main directly proportional to the quality of their food, their personal surroundings—in short, their physical and mental nourishment.

* * *

SIR HIRAM MAXIM, writing in this Magazine in 1897 and again in 1898, pointed this out very clearly by a comparison of the British islands, and western nations generally, with the nations of eastern and southern Europe. Because the Briton was freer, better fed, better housed, better taught, better endowed with ideals of cleanliness and order, he met and overcame the supposedly overpowering sea-forces of the Spaniard in the time of Queen Elizabeth. Persistence in their respective tendencies made the disparity in efficiency between Northern and Southern blood even more apparent when the Spanish and American fleets met off Santiago. And, as Sir Hiram urged, this was so in large measure because war has become a matter of using highly adapted mechanical appliances and wielding huge mechanical forces, operations demanding educated intelligence—that is, a good order of nerve fibre and brain cell, the product of proper nourishment, hygienic living, and suitable exercise; or in other words, of an advanced state of widespread material civilisation.

* * *

SIR HIRAM chose military instances merely because they were most concretely impressive. They serve only to point conclusions to be applied far more widely through the whole range of engineering occupations which make up national industry. The same conditions which make a good gunner will make a good artizan. Mr. Longmuir starts, then, on sure foundations when he seeks to better Britain's position by raising the physical condition, and with it the aspirations, of the British workingman.

* * *

THE question immediately presented to employers is whether they are not suffering decay to set in at the bottom of the industrial structure. With the growth of works, the disappearance of personal contact between master and man, the rise of a distorted idea of individual independence which is actutually selfish indifference—the lives of employer and employee (at least, during a cycle which is perhaps happily swinging back to better things) have been drawing farther and farther apart. At the same time, the pressure of life has been constantly rising, especially in towns, where so many of the mechanical industries are situated. The problem of housing, which in itself covers some of the most important influences on the physical and mental stamina of the individual, is becoming particularly difficult, and the compression cramps most those who are singly least able to resist—the working classes. Most employers would say, no doubt, that they cannot take knowledge of the home surroundings of their working people. But it will prove that they can and they will if they are convinced that, under present conditions, one of the chief elements of past success is decadent. Mechanical labour is scarcely beyond its second generation. The blood of the sturdy English yeoman, of the keen Yankee country lad, was its vital fluid. How long can this endure the de-oxygenating and de-vitalizing atmosphere of a low-plane city life?

* * *

In his article on "The Location of the Shop—Shall it be City or Country?" in The Engineering Magazine for April, 1896, Mr. H. L. Arnold referred to the better quality of country labour, but to the general preference of manufacturers for a city location on account of the greater flexibility of volume of labour which it permitted. The past five years have seen a remarkable spread of interest in the comparatively new institution designed to combine the advantages of both situations—the industrial community—described, in type and in many succesful working examples, by Mr. Patterson in the Works Management number of The Engineering Magazine (January, 1901), and by Mr. Going in the issue of the Magazine for April last. At first glance this looks like a return to the paternalism of an earlier order of labour relations, but the likeness is superficial only. There is no sacrifice of independence on the part of the employee nor assumption of control on the part of the employer in these manufacturing villages, planned and built as an integral part of the manufacturing enterprise. The managers of the works, as Mr. Going suggests in his article above referred to, act merely as trustees of the interests of the workmen in securing land for them on terms as favourable as they make for the works; they act merely with the same consideration which an honourable active partner displays for an absent one—the same joint regard for the minority interest which the majority stockholders of an incorporated company are morally and legally bound to show.

* * *

The motive of this newly reawakened care for the physical and mental well-being of the workingman is by no means simply philanthropic. It is the clear conviction, tersely expressed by Mr. Orcutt in his review of "Machine-Shop Management in Europe and America" in this Magazine during the first half of 1899—the conviction since confirmed by Mr. Patterson in our Works Management number—by Mr. Canniff, writing of the handling of railway men in our pages last April—by Mr. Going, discussing arbitration in The Engineering Magazine for February, 1901—by Sir Benjamin Browne, and Mr. Cokely, and Mr. Roland and the late Mr. Slater Lewis, and in fact every advanced thinker on labour problems who has written in this Magazine—the conviction that *it pays* to enable the worker to keep himself well housed, well fed, well provided with hygienic necessities, well trained in the elements of knowledge on which his work depends and in the practical use of his faculties. Strange that it should take argument and a sort of *renaissance* of industrial science to convince the world that propositions it would accept as axiomatic, applied to a horse, are true when applied to a human worker! And as competition becomes more severe, the question becomes not one of adding to profit by increasing the output-capacity of the worker, but of averting loss of trade; for this loss will surely be the penalty of neglect to uplift the physical, mental, and moral standards and environment of the factory employee or operative.

IN Britain the conditions of land tenure fill the problem with difficulties not met with in America—difficulties which may well deter an industrial manager otherwise fully convinced of the desirability of transplanting his works and his employees to a broader and freer site. How grave the "landlord incubus" has become in its effect on British industrial conditions is broadly sketched by Mr. Phillips in his study of "Britain and Her Competitors in Iron and Steel Making" (THE ENGINEERING MAGAZINE, May–June, 1901). It is not likely, as Mr. Phillips suggests, that any radical change will be made in this matter by Parliamentary legislation in the near future. The extension to England of the measure passed for the relief of Ireland, which has in large measure settled the "Irish question," is not soon to be anticipated, but industrial interests quite as strenuously as agricultural interests demand that Britain shall speedily adjust her land system to principles of "occupying-ownership." Meantime it is the more incumbent upon the owners of large works, who are in position to secure the fee of land sufficient for their purposes, to see that provision is made for housing their work people. They can with little difficulty make arrangements which their workmen are unable to carry through individually and unfitted to undertake collectively. The settlements at Bourneville and Port Sunlight instance what can be done by enlightened management in this direction.

* * *

THE striking difference between Mr. Longmuir's philosophy and that of the trade unionists is that he would level mechanical labour up from the bottom, while they would level it down from the top. The difficulty of the relatively low productive capacity of many workers—a difficulty admitted by labour economists generally—he would relieve by increasing their productivity through better nourishment and cultivation, thus bringing them nearer to the standard of their abler fellows. The trade unionist would meet the same situation by limiting the output of the more capable worker so as to lower him nearer to the level of his under-powered neighbour. Sir Hiram Maxim quotes one of his foremen as saying: "'If the strong and healthy men do more work than our weaker comrades are able to do, what is to become of our weaker comrades?' He pointed out that * * * it 'was necessary for the stronger and more skilful mechanics to reduce the output to the rate at which these less favoured brethren were able to do it.'" It is really a question which is most striking—the generous altruism inspiring the proposal, or the hopeless fallacy of the conclusion reached. It is hopeless because it attempts to ignore the whole principle and process of evolution—because it attempts to reverse the course of natural development. It is fallacious because it assumes the false premise that the condition of the least fit will be relieved of its disadvantages if the fittest will only sacrifice or decline to profit by their fitness. If the proposed measures could be carried out, they would surely lead to rapid degeneration and ultimate extinction of the race. Mr. Longmuir's proposal, on the other hand, leads broadly and steadily upward, harmonising with and accelerating the movement of evolution by making more individuals more fit to survive.

* * *

THE amusing vagaries of the little primer of the Portuguese language entitled "English as She is Spoke" have frequently been commented upon, but they will bear referring to once more in connection with some of the peculiarities in the use of other languages in engineering and technical publications. Thus the well-known German company for the manufacture of electrical machinery, the Allgemeine Elektrizitäts Gesellschaft, some time ago issued a very handsome catalogue illustrating and describing the various electric stations designed and built by them in Berlin. This catalogue was reviewed at length by an engineering journal of high reputation, and in the review these various stations were described as having been "designed and constructed by Geplant und Erbaut, of the Allgemeine Elektrizitäts Gesellschaft." The existence of these two distinguished engineers must have been a revelation to the men who actually did the work, and it seems curious that they have not been heard of since on either side of the Atlantic.

Another instance, and this in the columns of a well-known electrical paper, is the information that certain three-phase generators at the Paris Exposition were exhibited by Messrs. Electricité & Hydraulique, of Charleroi, a firm which seems to have disappeared as quickly as it sprang into existence.

The most amusing example of twisted language, however, which has recently come to our notice is found in a continental mining journal, in which the advertiser, desiring to call attention to the fact that he sells various ores of arsenic, publishes the following, over his name:

Minerais d'Arsenic
(Mixed Pickles) de Cuivre, Fer et Manganese.

Doubtless this enterprising gentleman had heard that in Germany and elsewhere the arsenite of copper was commonly called mispickel, and his efforts should be rewarded with business success.

The real importance of the subject is seen in the numerous absurd blunders which appear in circulars, catalogues, and advertisements which are prepared by those who are not natives of the country in which business is sought, the waste of money in such mistaken methods being quite material. In these days of international trade and engineering it is most desirable that customers should be addressed in their own language, but not in such broken and distorted imitations as to make the advertisers the laughing stock of the people they desire to impress.

* * *

The advent of engineering methods and appliances into modern life has brought with it not only comforts and conveniences, but also dangers and risks against which proper protection is not always made.

Boilers are now operated under pressures far higher than were intended when the existing inspection laws were enacted, while speeds and methods of connection have been materially modified, without corresponding modification in the methods of protection. Similar facts exist in connection with the manufacture and storage of explosives, with details of building construction, with the position and operation of machinery liable to produce dangerous vibrations, and with numerous installations of power, lighting, and other industrial operations.

Under these conditions we endorse most heartily the recommendation of the president of the Franklin Institute, Mr. John Birkinbine, as to the desirability of investigating the whole subject, both in respect of existing legislation and its imperfect enforcement, and with regard to the desirability of new laws and regulations.

It is to be hoped that such investigation as may be originated by the Franklin Institute will meet with the support of the community at large, not only in America, but on both sides of the Atlantic.

REVIEW OF THE BRITISH PRESS

Electricity in the Nineteenth Century.

Mr. Charles Hawksley, in his presidential address to the Institution of Civil Engineers, takes a general retrospect of the advance made during the nineteenth century in civil engineering, which, under the far-reaching definition of the Institution, includes all branches of engineering. He considers the several divisions in order, but in this place there will only be room for some of his remarks on the subject of electricity.

"At the commencement of the nineteenth century our knowledge of electricity was practically confined to lightning conductors, invented by Benjamin Franklin in 1752, and his various other experiments and observations, and to the pile or battery discovered by Volta in 1799, following on the work of Galvani begun in 1786. After the invention of this battery the progress of electric science was extremely rapid. By its agency Nicholson and Carlisle in 1800 succeeded in decomposing water. In 1802 Sir Humphrey Davy showed the electric arc in the Royal Institution, and in 1807 he laid the foundation of electro-chemical work by decomposing potash and soda. The first great practical application of electrical science was undoubtedly the telegraph, which was the outcome of many years of persevering effort on the part of inventors and scientific investigators," being placed on a commercial basis by Cooke and Wheatstone in England and by Morse in the United States before the middle of the century, and at the present time the length of land lines in Great Britain and Ireland alone is 33,000 miles, and in the whole world about 770,000 miles.

"The first submarine cable was laid between Dover and Calais in 1851 by Crampton, following up the idea worked out by the brothers Brett, and between England and Ireland in 1853 by Mr. (afterwards Sir Charles) Bright, who also laid the first Atlantic cable in 1858. Although it was not until the above-mentioned dates that communication with distant parts of the world was achieved, there are now 1,769 submarine cables, having a total length of 189.000 nautical miles. Of these 1,349 cables of 20,000 nautical miles are under various Government administrations, and 420 cables of 169,000 nautical miles are owned by companies, nearly all of which are incorporated in Great Britain."

The latest development of electrical means of transmitting messages is wireless or space telegraphy, which has recently been brought to practical success in the hands of Marconi and other workers, and is found particularly useful in communicating with ships at sea.

The invention of the telephone, like that of the telegraph, was the outcome of many researches and experiments, but it was Bell's fortune to produce the successful commercial instrument in 1876, since which time the use of the telephone has grown with extraordinary rapidity, particularly in America and in some parts of the European Continent.

The discovery of the means of generating electricity from mechanical power constitutes the keynote of all the electrical work of the latter half of the nineteenth century. Michael Faraday, when studying the relations between electric currents and magnets in 1831, made the exceedingly important observation that an electric current would be induced in a wire moved in a magnetic field. This discovery contained the fundamental principle of magneto-electric induction, and is perhaps the invention of all others which has been of the greatest service to electrical science, for it forms the basis of the dynamo-electric machinery which has made the generation of electric currents economically possible.

The modern period of electricity may be said to date from the Paris Exhibition of 1881. Before that time the beginnings of arc and incandescent lighting had been made, but the commercial history of these branches of electrical engineering has been made very largely in the past twenty years.

"The use of electricity for lighting was soon followed by its application to numerous other purposes, the most notable of which was motive power. At the present time electric motors are not only largely employed on tramways and electric railways, but they are rapidly taking the place of steam, gas, hydraulic and pneumatic machines for actuating machinery such as cranes, workshop tools, riveting appliances and lifts. The great opening for the utilization of electricity is evidenced by the formation of companies for the supply of electric energy in bulk in various parts of the United Kingdom. With energy generated on a large scale where coal is easily obtainable and thence conveyed to and distributed in cities and manufacturing areas, the electrical industry will be enabled to compete on a more favourable footing than is now the case with those countries endowed by nature with a plentiful supply of water power."

But perhaps the most remarkable advance made in the closing years of the nineteenth century has been in the application of water power to the generation of electrical energy, notably in countries, such as Switzerland and the United States, which are blessed with an abundant water supply. The colossal plant at Niagara is but one of many centers whence current is radiated in all directions to be utilized in lighting, transportation, and all kinds of manufacturing industry.

Even without any new and radical discoveries, the development of what we already possess affords ample scope for the efforts of our electrical engineers in the new century; but who can say that invention will not produce new wonders which will make even the great advance of the nineteenth century appear relatively insignificant?

The Future of the Steam Turbine.

Ever since the time of Watt steam engineers have been endeavoring to design some form of rotary engine which should do away with the disadvantages of the reciprocating motion of the cylinder engine, but it is only recently that the true principle of such engines has been applied. The steam wheel of Branca, and its predecessor, the oelopile of Hero, were laughed at as toys until more serious study has shown that in the modified forms of steam turbines they may be made highly efficient and satisfactory rotary engines.

From a paper on the future of the steam turbine, by Mr. W. E. Warrilow, in a recent issue of the *Electrical Review,* some interesting facts about the advantages of the steam turbine may be gathered.

Possessing but one rotating part and requiring no special foundation, it embodies all that could be desired for coupling to any type of dynamo for direct or alternating current. The improvements effected in its construction and its employment in a large number of electricity works in this or other countries should indicate that it is destined to fill a prominent place in the generating stations of the immediate future. Unlike the early undertakings, the schemes which are now planned demand units having capacities running into thousands of kilowatts, instead of hundreds, so that the class of engine which the turbine represents has every opportunity of appearing to the best advantage, as far as steam consumption is concerned. This question of consumption of steam in pounds per kilowatt has been a favourite one with consultants, the makers of engines being encouraged by the offer of a bonus to reduce it as much as possible. The guaranteed performance of a reciprocating engine in this respect has often given it the preference over such an engine as the turbine, though no calculation has been made as to the possibilities of either engine to get out of order, or increase its steam consumption with time.

An important feature of the steam turbine, not always considered, is the freedom from great or sudden angular variations in speed. This defect in reciprocating engines has been noticed at length elsewhere in these columns, and it is one which is of constantly increasing importance. With its high rotative speed, and entire absence of reciprocating parts, it is practically impossible for any appreciable variation in speed to occur in the course of a single revolution, the speed changes necessarily extending over a number of revolutions, and being gradual in their nature, while with the use of properly proportioned governors, even these gradual variations in speed may be kept within very narrow limits.

A modern turbo plant of 1,500 kilowatt capacity will stand on a floor space of 728 square feet, and will have its own condensing plant at that. No foundations are needed for its reception, and no oil is necessary for the lubrication of the rotating parts acted upon by steam. In both these items it will be at once seen that large economies in time and material will be effected. The absence of oil in the steam especially enabling the condensed water to be returned to the boilers. The machine when delivered can be assembled on its particular portion of the engine room floor, and no vibration will take place while the plant is in motion. The appearance of the engine room will also be greatly enhanced, in that the turbo sets occupy little head room, and consequently will cut off little or no light from the windows. The small vertical space needed also does much to decrease the cost of buildings as well as the steam and exhaust piping for the turbine. Combined with these are, the little attention required both for running and maintenance, and the ease of manipulation for parallel running on account of the even turning moment.

That the early types of turbine were extravagant in steam is well known, but this fault was due to the comparative scarcity of data in the design of such engines, as well as the fact that very small units were required for electric supply purposes.

The day of the small station is, however, about to depart, so that the turbo set can appear to its best advantage under the improved conditions, and where the reciprocating engine must ultimately fail, the turbine can be looked to as a reliable substitute. Such a fact is not one to cause regret on the part of engineers; rather should they welcome the new engine as a means of deliverance from the difficulties which progression on the present lines must assuredly bring. The existing state of competition in all industries, but especially the electrical one, will no doubt keep the reciprocating engine in our midst for some years to come, though the same competition will also bring more prominently to the front the steam turbine, even to the extent of finally ousting its rival.

The Commercial Relations of Gas and Electricity.

When electric lighting was first introduced, the conclusion was suddenly reached that gas works were doomed, and there was an abnormal fall in the value of gas shares which created a flurry in the stock market. As it gradually appeared that there was room for both gas and electricity, this scare subsided, and at the present time both industries are flourishing side by side, and if not always on terms of amity are at least in relations of ordinary business competition.

It is altogether possible, however, that these two important industries may be linked together by close commercial bonds, and become of great benefit to each other. In an address before the Manchester section of the Institution of Electrical Engineers, Mr. C. H. Wordingham shows how the introduction of gas power may effect this result. He says, in part:

"That gas engines driven with producer gas will in the future supplant steam in electrical generating stations, there can be little doubt. But their use will not be confined to stations of abnormal size, for their inherent advantages are very great. The consumption of fuel is but little more than half that of steam-driven plants; and the cleanliness and compactness of the system, coupled with the reduction of radiation and stand-by losses, render possible great strides in the direction of cheapening electrical energy even in very small stations.

"There is one method of supplying small towns and villages which might prove a cheap and easy solution of giving to them the advantages of electrical energy. There are few towns so small as not to have gas works. Why should not the gas company establish a producer plant, and sell the gas to a locally formed electrical company or to the local authority to use for driving electrical generators? It would not be desirable for the gas company to undertake the electrical portion of the business for themselves, partly because their staff would not have the necessary experience, and partly because they would be tempted to stifle the electrical work. On the other hand, by the suggested course, each portion of the work would be looked after by those most competent to deal with it; and it would be to the interest of both parties to make the electrical undertaking succeed, for the gas company could make as great a rate of profit on the producer gas as on the ordinary lighting gas, while still enabling the electrical company to produce cheaply.

"In considering this matter it must not be forgotten that the preparation of producer gas for gas engines is by no means a simple matter; and if to this be added an ammonia-recovery plant, a considerable amount of skill is required on the part of those looking after the manufacture. This skill is available in gas works; and for this reason it would pay to put down recovery plants for producers working on a much smaller scale if the operations are carried on in connection with such works than if the plant were isolated. This extension of the gas company's make would not be at the expense of their existing business; for it is a matter of experience that the introduction of the electric light sets a higher standard of illumination, and actually increases the demand for gas for ordinary purposes. Hence the introduction ot the electric supply would be a clear gain to the gas company."

There is little doubt that the use of gas power is more economical than steam, but it hardly seems probable that the installation of a gas producer plant demands more skill than would be required in the electric station in connection with the gas engines and electric generator, and it does seem as if the proper place for the gas producer would be in the electric station. Mr. Wordingham's proposition appears to be all right for very small towns, but for anything else we fail to see why a producer plant and gas engines might not very well replace steam boilers and engines. There is no need for the gas plant to be at the same place as the electric plant, although both might well be without the city boundaries, and thus suppress the smoke nuisance by keeping away from the sections which might be disturbed by it.

The gas engine, or rather some form of the internal combustion engine is destined to be the motor of the very near future, and this is as true of electric generating stations as it is of other power plants.

Scientific Discovery.

Sir W. H. Preece is always interesting in his public addresses, and his broad grasp of the field of pure and applied science makes his utterances especially worthy of notice. In his recent address before the Society of Arts, published in full in the *Journal* of the society, the general progress of scientific discover in the past century is dealt with, and some forecast of the future is made. That there is much in the immediate future is undoubted.

"The workers in the realm of scientific research are increasing in compound ratio. Their weapons of attack upon nature's secret storehouses are increasing at the same rate. The practical developments of these unknown principles must necessarily grow in ever widening circular waves of practical utility and increased human comfort. It is dangerous to prophesy, it is simple to forecast. It is impossible to surmise the discoveries that are to come. We only know that they will be absolutely unexpected. But we can observe the progress of existing practical applications of science, and by watching the trend of advancement, and following the motive causes of progress, guess at what is likely to be the result in the immediate future."

Sir William Preece enumerates the great scientific discoveries of the nineteenth century to be as follows:

The principle of evolution.

The atomic structure of matter.

The existence of the ether and the undulatory theory of light.

The principles of electro-magnetic induction and electrolysis.

The principle of the conservation of energy.

These he proceeds to discuss at length, showing their influence upon what we may expect to follow and supplement them.

In the course of evolution we may expect selective modification to be influenced by the mainsprings which are acting most powerfully: the struggle for power, the race for individual wealth, the pursuit of knowledge, the combat with disease, the advance in comfort of living; and these forces may be expected to act in the future as they have in the past.

The study of the atomic constitution of matter may lead to the discovery of many new elements, or possibly to the revelation of the one fundamental element, of which all others are but varied manifestations.

The existence of the ether is still inexplicable in its mechanical structure, although its reality is even more fully accepted than ever. It offers no resistance to wave motion, and in it energy is not dissipated away into heat, as in the undulations and vibrations of matter. Still no final theory of its structure has been produced, and that problem still awaits its solution in the twentieth century.

Electromagnetic induction is only beginning to unfold its possibilities. The communication of energy without the use of metallic or other material conductors is within sight, and in the form of space telegraphy has been partially realized. Electrical decomposition may be followed by recomposition, and the artificial synthesis of organic compounds become commercially and wholly possible. With all these comes the principle of the conservation of energy uniting the action of force, motion, and matter in ever changing relations, but always with an unchanging sum total.

Sir William Preece discusses in an able manner the present practical applications of energy, and this most interesting portion of his address should be perused at length. In all he shows the intensely practical uses of scientific discovery, and emphasizes the fact that the small details of our everyday life are closely bound up with the work of the engineer, the physicist, the chemist, the so-called man of pure science. In it all is seen the fundamental fact that progress in all branches of life is due to certain motive causes working on the principle of evolution; that these causes are within the reach of our observation; and that they have only to be discovered, so that, by their encouragement, we may secure, during the coming century greater and further advances in civilisation and knowledge.

The Balancing of Locomotives.

The question of balancing engines of every sort is a matter which is receiving increasing attention, and elsewhere in these columns we have discussed the solution of the problem as applied to marine engines. In a paper recently presented before the Institution of Mechanical Engineers, Professor W. E. Dalby treats of the balancing of locomotives, dealing with the method of obtaining the magnitude and position of the balance weights for locomotives, and also examining the different ways of dealing with the reciprocating masses in coupled engines.

The method described by Professor Dalby is semi-graphical in its nature, and cannot be discussed in detail here, but some general idea of the principles involved may be given.

In a locomotive a portion of the masses are rotating about the axis of the driving wheels, another portion has a reciprocating motion, coming to rest twice in every revolution, while still another portion has a motion combined of these two. The rotating masses can be entirely counterbalanced by suitable weights, attached to the driving wheels; the reciprocating and the mixed portions may be partially so balanced. In the early history of the locomotive no balance weights were used, but about fifty years ago, as speeds and weights increased, balancing was found necessary, and at first the balance weights were made equal to the whole weight of the moving parts. Experience showed that this was too great, and, by the method of trial and error, practice gradually resulted in the adoption of weights equal to five-eighths of the moving parts for single driving wheels, and to two-thirds the weight for coupled engines.

The correct weight, as well as its position, depends upon the relative magnitude of the various forces for any particular case, and the method of Professor Dalby enables this to be determined graphically by reducing all the forces to their equivalents at crank radius, and then constructing a force polygon. The proper weight will then be that which causes the force polygon to close, in accordance with the general principles of graphical statics.

The method is shown in detail as applied to some existing engines, and the results show that the above proportions as determined by experience are very nearly those found by computation.

In many instances compound locomotives are now made with four cylinders, two being outside and two inside, and with such engines the Yarrow-Schlick-Tweedy system of unequal crank angles, as applied to marine engines, is applicable, and this has been tried in some cases in Germany.

The principal consequences of imperfect balancing, apart from vibration, are the effects upon the track and upon bridges and other structures over which the engine may be run. The so-called "hammer blow" results from too little or too much weight in the counterbalances, and it has been maintained that light rails have been broken by heavy engines, the breaks appearing at points distant from each other by the circumference of the driving wheels.

In coupled engines the effects of improper distribution of the balance weights between the two driving wheels appear in the wear upon the coupling rods, crank pins, and brasses, a fact which has been well known to practical locomotive engineers for a long time.

The general tendency in railway practice is to use somewhat less balance weights than formerly, the guide in this respect being the observed effect upon the wear of tyres. The whole tendency at present is rather to make the balancing a part of the distribution of the necessary weights, and to use as little additional weight as possible.

It is evident that in a reciprocating engine perfect counterbalancing is impossible, and that the best which can be done is to effect a compromise between conflicting conditions. The true solution of the problem is to replace the reciprocating motor with one entirely rotary in its motion, and in this respect the great advantage of the electric motor is apparent. The practical limitation to high speed with steam locomotives is found in the strength of the reciprocating parts, the breakage of connecting rods and coupling rods being the weak point. With the electric motor the limit is found in the resistance of the rotating parts to the action of centrifugal force, and this is a much higher limit than that for the reciprocating parts.

Technical Education in England.

In a recent editorial in *Engineering* the question of the importance of making technical education the direct means of developing industrial progress was discussed in connection with an account of the "Central Stelle" established and maintained by an association of manufacturers in Germany. This especial institution had for its object the investigation of methods of manufacturing explosives, but there are other similar ones in other lines of work. There are no precisely similar institutions in England, nor indeed anywhere else, although we believe there is some association of methods and information among the chemical laboratories of the iron manufacturers in the United States. The latest educational endowment of Mr. Andrew Carnegie is intended to found such a general institution for the advanced research in Washington, in connection with the various government collections and institutions, and altogether there seems to be a general awakening to the close connection between advanced technical education and material prosperity.

It is difficult to say where the limitations of this question are to be found. Some maintain that it is impossible to expect manufacturing and industrial establishments to permit the details of their methods to be made public or to get into the hands of possible rivals, while in other quarters it is believed that publicity within reasonable limits is for the benefit of all concerned.

This question was agitated to a limited extent at the recent meeting of the British Association, and from the criticisms there made of the Board of Education it is clear that many are of the opinion that there is room for improvement in educational methods in Great Britain, especially in connection with industrial development.

The true place for the foundation of technical training is in the primary schools, and it is in these that there is much room for improvement, not so much in the matter as in the manner, and in the development of correct habits of thought. With such a foundation, the development of special training centres can properly follow; without it, they would be worse than useless.

Electric Traction on the Underground.

The electric operation of the "Inner Circle" underground railway in London will soon be an accomplished fact, owing to the recent decision in favor of the system variously known as the Yerkes, American or direct-current, and it may be of interest to review the proceedings before the arbitrators which led to the decision in question, as reported in *Engineering*.

The Inner Circle is worked by two companies, the Metropolitan and the Metropolitan District, the latter called the "District" for short, and the Great Western Railway also runs some trains over parts of the system, which it is also purposed to connect with other surface and long distance lines.

The various proposals for "electrifying" the Underground narrowed down to two, one plan being advocated by the District company, the other championed by the Metropolitan. The former plan is to generate high-voltage three-phase current at the power house, convert to 500- or 600-volt direct current at rotary-converter sub-stations placed at convenient intervals along the line, and collect this current from a third rail for use in the car motors.

The Metropolitan scheme is to generate high-tension polyphase current as in the other plan, but then to transform it at the stations on the road down to 3,000 volts and distribute it along the line by overhead wires, whence it will be collected by trolleys and delivered to polyphase motors on the cars.

The former system is the one used and about to be used on various roads with heavy traffic in American cities, and the direct current part, which immediately concerns the working of the line, is universally employed on American and British electric railways, as well as on most Continental ones. The polyphase in the form proposed by the Ganz Company, is most closely approximated by an experimental road at Budapest and the recently built Sondrio-Lecco railway in Italy.

It is obvious that only one system can be used on the Inner Circle, and as the conflicting interests would come to no agreement, the matter was submitted to an arbitration committee, on which Mr. Horace F. Parshall represented the District company, Mr. Thomas Parker the Metropolitan, while the Hon. Alfred Lyttelton was appointed umpire by the Board of Trade. The principal counsel for the District company was Mr. Fletcher Moulton, while Mr. C. A. Cripps acted in a similar capacity for the Metropolitan.

In opening the case for his company, Mr. Moulton stated that the District did not only own a portion of the Circle, but also a considerable section beyond it. In the Inner Circle the District owns 4 miles; there is about 1 mile which is owned jointly; the Metropolitan owning about 7 miles. The outlying connections are partly feeders and partly independent traffic lines and extend over about 25 miles. The traffic on all the lines is naturally very dense, and especially so on the Inner Circle, where there are 220 trains a day making the whole circuit and about twice that number running over a portion of the underground road.

The conversion of this system from steam to electric operation is a serious matter, involving a financial risk which depends on the probable traffic to be secured by the change. But there is really no electrical risk if the plan advocated by the District Company be followed. In America there are about 21,000 miles of electric lines operated on this system, some of them light tramway lines, but some of them easily comparable with the Inner Circle in the frequency and density of their traffic. All this electrification of railways has been accomplished within the last 15 years. Large sums have been spent on experiments. Various systems have been suggested and tried and laid aside; numbers of devices have been worked on paper and let alone. There has been, however, a steady approach to one definite type of electric traction, which has been found to answer all requirements. This type the District proposed to use, and in any project such as the one under discussion, two main considerations must not be lost sight of: First, the system must be a safe one; and, second, there must be a certainty of uninterrupted traffic.

In regard to the first consideration, by the District system the dangerous high pressures were confined to insulated, buried conductors leading from the main station to the sub-stations; and concerning the second, the vast amount of experience gained in America and elsewhere was an assurance of continuous operation.

Mr. Yerkes testified that he had been in command of between 500 and 600 miles of street railways, all of which he, together with others, had either built or changed and improved; part of these were tramways, part elevated roads, part low-level, and part cable roads, all running through a closely built up city, and with trains traveling at a three-quarter minute headway. The whole of the Chicago lines transformed or built by Mr. Yerkes carry about 480,000 passengers a day. All these lines are on the direct-current system, which has been doing good service year after year. The usual working pressure is 500 volts, and there has never been a death due to electricity on any of these lines.

Mr. E. W. Rice, third vice-president of the General Electric Co., stated that it does not make any difference to his company whether they supply polyphase or direct current machinery, provided one will do the work as well as the other. He said that three-phase generation and transmission at high pressures, with ultimate conversion into direct current of 500 or 600 volts for use on the line, was the system now practically universally adopted in large traction undertakings; he did not know of, and did not believe there was any better one for driving tramways and elevated roads as well as tunnel roads where the service requires frequent stops and high acceleration at frequent intervals.

Mr. Swinburne confirmed in every point the evidence given by Mr. Rice, and Mr. Chapman and Mr. Philip Dawson, both engineers of great experience in traction work, were equally emphatic in favor of the direct-current system, while Mr. George Estall, engineer and locomotive superintendent of the District company, deprecated the use of overhead wires on the Underground whatever be the system of traction resorted to.

Mr. Cripps opened on behalf of the Metropolitan Company, which, he said, might claim to be the predominant partner, as it had a greater interest than the District both in the Inner Circle and in the interpolated, or outside traffic, its outlying system of extensions and branches amounting to more than 50 miles, without counting the line to Quainton Road. His clients were actuated by but one desire, which was to get the best possible system for the Inner Circle and their outside roads. He pointed out that the alternating-current installation would be much cheaper than the direct-current one, owing to the absence of rotary converters in the former; besides this, there would be 13 per cent. more power required by the direct current system than by the alternating, owing principally to more leakage from the line in the former. This greater power requirement would increase the coal consumption and the operating expenses,, the latter being also greater with the direct current, owing to the necessary attendance on the rotary converters.

In regard to safety, Mr. Cripps made the point that the overhead wires of the alternating system were inaccessible and protected by safety devices, while the live third rail of the direct-current system, even though carrying a lower pressure, was a constant risk to workmen and the public.

Mr. O. T. Blathy, manager of the Ganz Company, testified concerning the technical side of the alternating project, and endeavored to show that all the electrical difficulties had been overcome and that there could be no question about the satisfactory and continuous operation of his company's system on the Inner Circle. The experience on which he based his evidence was largely gained on the experimental line at Budapest and on the Sondrio-Lecco railway, though polyphase traction, with important differences in detail, has been successfully applied to other roads, notably that between Burgdorf and Thun, and the one up the Jungfrau, in Switzerland.

Mr. Gisbert Kapp, Mr. Koloman de Kando, Prof. J. A. Ewing, Major Philip Carew, Mr. Ernest Talbot and Prof. Sylvanus P. Thompson all testified in favor of the alternating system, but some of this testimony was considerably shaken on cross-examination by Mr. Moulton and Mr. Parshall.

Summing up, it may be said that the points in favor of the Ganz, or alternating project are a possible economy in first cost of installation and operating expenses, and, perhaps, a better adaptability to outside connecting railways, if these extend to any distance. The great, and probably the determining objection to it is its experimental nature, particularly for such a road as the Inner Circle, the last place in the world in which to try experiments.

On the other hand, the direct-current system is admitted by all parties to be perfectly feasible for the Underground, and has stood the test of years of experience on all kinds of roads, and it is claimed by its advocates, that, taking everything into consideration, including possible interruptions and breakdowns, it will be decidedly the better, even from a purely economical standpoint, for such a line as the Inner Circle.

It is not surprising, therefore, that the decision of the arbitration committee has been in favor of the direct-current system.

REVIEW OF THE CONTINENTAL PRESS

The International Bureau of Weights and Measures.

THE great importance of the maintenance of correct standards for measurements of length, volume, and weight has been realized for a long time, and since such dimensions enter into many commercial transactions to almost as great an extent as the money consideration, the establishment of such standards has rightly been considered as a function of government. Indeed the question of standards of measurement have advanced somewhat further than monetary standards, since it has reached an international stage, while international money is yet to be attained.

A recent series of papers by M. C. E. Guillaume, appearing in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale,* gives an excellent account of the remarkable work of precision which is being conducted under the auspices of the International Bureau of Weights and Measures, at Breteuil, near Paris, with especial reference to the maintenance and reproduction of metric standards.

The metric system has now completed its first century of existence, and its use has extended into many countries, having been especially welcomed in those lands in which confusion existed because of uncertainty, unreliability, and multiplicity of older units. Since the rather sentimental idea of having the metre represent a definite portion of the circumference of the earth has been abandoned, it has been found advisable to select a standard more easy of comparison, and hence the distance between two marks on a bar of metal is accepted. This distance is really a certain portion of the double toise used by Delambre and Méchain in their measurement of the arc of the meridian between Dunkirk and Barcelona, and has been established by order of law, a much simpler and more accurate method than that of terrestrial measurement. The prototype of the metric system, therefore, is the *Metre des Archives,* with its two companions the *Mètre du Conservatoire* and the *Mètre de l'Observatoire.* From these the measure of weight is also supposed to have originated, being intended to be the weight of one cubic decimetre of water, but the variations which have been found to exist in this determination have caused the actual standard of weight to be that of a certain metallic weight legally designated as the standard kilogramme.

The gradual advances which have been made in methods and instruments of comparison, together with the higher degree of precision required, has made it necessary that some provision should be made for this work, and as a result of the work of scientific men in various parts of the world the International Bureau has been established in Paris. This bureau was the direct result of the International Metric Commission, which, dating from 1870, has had in hand the solution of a number of the important problems of metrology.

The work of this commission is far too voluminous to be discussed fully here. First of all came the exhaustive study of the *mètre des archives* in order that its actual length might be determined, and that accurate reproductions might be made, thus permitting the establishment of an international metre. To this is added the production of standards of weight and the practical solution of all the problems connected with these determinations.

M. Guillaume gives an interesting account of the buildings and equipment at Breteuil, showing the excellent manner in which it is adapted for the work. The principal instruments naturally are the comparators, by Brunner, by the *Société Genevoise,* by Bariquand & Marre, and by Starke & Kammerer. In connection with these are balances, thermometers, normal barometers, and the innumerable appliances and auxiliary apparatus.

Since the question of expansion and contraction of the metals used for standards of length is a most important element in the comparisons, much attention has been given to thermometry, and many of the researches in this direction have been carried under the immediate direction of M. Guillaume himself. This work forms in itself an important study in thermometry, and includes not only the question of graduations, but also the expansion of various kinds of glass, the changes in the zero point, the calibration of the tube, the influence of external pressure, etc. With these researches is also included a study of the air thermometer, and of gas thermometers, and the results, being plotted in the form of curves, show very clearly the variations in the different constructions. At the Bureau there have also been made studies of devices for measuring very low temperatures, thermometers using toluêne having been shown to indicate temperatures down to —75° C. within one-twentieth of a degree. Pyrometers for the measurement of high temperatures, have also been investigated.

The two normal barometers of the Bureau are illustrated and described in the paper. These are so constructed as to permit the height of the mercury column to be measured by means of observing telescopes reading a cathetometer scale, and every provision is made for the determination and correction of instrumental errors. With these instruments the atmospheric pressure can be determined within 1/100 of a millimetre of mercury.

The comparators are arranged for various kinds of work. Thus the Brunner instrument is arranged for the rapid and accurate comparison of standards of 1 metre in length, the bar to be examined being placed on a carriage together with the standard bar, and brought beneath the wires of two micrometer microscopes. The comparator constructed by the *Société Genevoise* is especially designed for the study of expansion of metals, being arranged with a trough of water which may be maintained at any desired temperature. It was with this instrument that M. Guillaume conducted the important studies of the nickel-steel alloys which resulted in the remarkable discovery of the very low coefficient of expansion of the 36 per cent. nickel alloy. Other comparators are used for the calibration of the rods used for the measurement of geodetic base lines, these rods usually being four metres in length, and hence being beyond the capacity of the usual instruments.

While the fact is generally known that the International Bureau of Weights and Measures is doing good work in its own especial field, it requires the perusal of some such detailed description as that of M. Guillaume to enable a fair idea of the high character of its investigations to be formed. The whole description shows how the modern physical laboratory forms a connecting link, not only between the man of pure science and the operative mechanic, but also how it enables the accuracy and precision of the trained investigator to be placed at the disposal of the practising engineer

Military Automobiles.

In view of the general interest in automobile vehicles, and their applications not only to pleasure carriages, but to many industrial purposes, the paper of Captain Douhet, recently presented before the Italian Electrotechnical Society is of interest. Captain Douhet treats of the automobile from a military point of view, and aims to show the conditions under which self-propelled vehicles may be expected to render service in military operations.

The relation of engineering to warfare is very clearly indicated by the opening statement in Captain Douhet's paper. As soon as any important invention is made among civilized nations, the first question is: How can it be adapted to the purposes of warfare? It is most natural that this query should be applied to the motor vehicle, especially since the difficulties experienced with horses have continually increased in recent years. Speed of movement, handling of supplies, command of artillery, all these, and many other vital points are intimately connected with the horse or his substitute, and notwithstanding the noble work which the horse has done in the past, his mechanical successor will be eagerly welcomed so soon as it proves itself equal to the many severe duties which are demanded.

While the present state of the art of automobilism is such that the requirements for military service are by no means fulfilled, yet it is only by a review of the present state that the line of work for the immediate future can be indicated. After examining the principal systems now in use, viz: steam, gasoline, and electric, the author passes to the actual conditions in warfare in which a self-propelled vehicle might possibly be used. The movements of an army may be analyzed in detail, and the possibilities of employing automobiles thus examined critically. In the mobilization of an arm upon the declaration of war the railways naturally play the principal part, and for this the automobile offers no advantages. When the troops are mobilized the army is put in movement as a whole. For the large units motor vehicles are evidently unsuited, but it is quite possible that certain small units might well follow the cavalry by the use of automobiles. Vehicles for this purpose would keep to the main highways, and would resemble in general features the motor omnibus, being really intended to be an accelerated substitute for marching. So far as the field artillery is concerned it does not appear feasible to use mechanical propulsion, and it would probably be better to provide more and better horses for this arm, a plan which is made possible by the use of automobiles elsewhere. For the transmission of intelligence and of orders the field telegraph naturally holds the first place, and the bicycle has shown itself to be a useful second. It is probable, however, that a gasoline vehicle would be valuable for this service where the roads were not choked.

In considering the possibilities of the automobile on the field of battle it must be emphasized that in future engagements the field will probably be very extended. An army composed of three army corps and one division of cavalry fills about 300 complete railway trains. At 24 trains per day this means 13 to 15 days for transport over a distance of say 100 kilometres, while on an ordinary road this distance could be marched in four days. When it comes to manœuvres on the field in the face of the enemy it must be obvious that automobiles are unsuited. Even assuming that the vehicles carried 50 men each, it would require 240 automobiles in constant readiness for a detachment of two brigades of infantry; 12,000 men. We come now to the movement of *matériel,* including the great mass of supplies which form the life blood of an army, and on which the failure of circulation means disaster. This service means the transport of supplies from the surrounding country, and from bases, to the army, the distribution to the main units and subordinate portions, and the removal of debris to the rear. Some idea of the magnitude of this service is seen when it is understood that for a force consisting of three army corps, and one division of cavalry, a total of 100,000 men, there are now required about 5,000 wagons, and 15,000 horses; and allowing 1 kilogramme per man and 5 kilogrammes per horse, there will be 200 tons of supplies to be handled daily. It is in this service that motor vehicles may well find applications, if they can be made equal to its requirements.

Bearing in mind the fact that the supplies cannot always be transported over roads, or that these latter will usually be in good condition, the essentials of vehicles for the service may be considered.

First of all comes the condition of stability. The service must be maintained; it must not be crippled by breakdowns; it must include ample strength in the vehicles and ample propelling power of a reliable nature.

Leaving for the present the precise construction to be employed, we consider the capacity and dimensions. At the present time the maximum weight is limited by the necessities of horse traction to about 5 tons. A larger capacity is desirable, but the limitations of the roadway must be taken into account, so that it appears that 10 to 12 tons is about the best capacity, with the provision of a limited number of vehicles of 20 tons for service in the transport of siege *matériel.* The length of the convoy is determined by the length of the vehicles, plus that of the motors or propelling power, plus the necessary space between the vehicles. It is therefore desirable to keep the vehicles short and the space between them a minimum. The ordinary speed of a convoy is about 4 kilometres per hour, but with motor vehicles this may be materially increased. It is necessary that the convoy should preserve its unity, and be at all times under control as a whole, and with these limitations the practicable speed may be from 8 to 12 kilometres per hour. With the ordinary horse haulage the usual distance traversed daily is about 40 kilometres, and in exceptional instances it may attain 60 kilometres. The principal limitation is that due to the horses, and hence the advantage in this respect, of substituting mechanically propelled vehicles. With automobiles the length of the daily journey depends the human element mainly, the machines being capable of almost indefinite endurance, if maintained in good working order.

The question of the fuel consumed by the motor vehicles is necessarily an important one, but it must be remembered that horses also require supplies to be transported for them, and that horses must be fed when idle, while the combustion of fuel ceases when the automobile is stopped. Assuming the relation of useful load to the total load as 0.66 per cent., the remainder after the load of fuel is subtracted will be the useful load, and knowing the fuel consumption per unit of distance traversed, it is a simple matter to compute the distance at which the total capacity of the vehicle will be required for its own supplies.

When all these and similar conditions are taken into account it will be seen that no one of the existing types of automobiles is capable of fulfilling them. The electric vehicle carries far too little useful load to be available. The gasoline-motor vehicle, as at present developed, is not suitable for transporting heavy loads, and requires too much attention to prevent breakdowns. The light steam automobile presents both of the difficulties of the preceding, but in a less degree. To these must be added the necessity for a large supply of water, and this, added to the fuel, liquid or solid, limits its radius of action. Steam traction engines, which have been advocated for hauling supply trains can be shown to give no greater speed or capacity than their equivalent in horses, and hence are out of the question.

That the problem will remain unsolved is by no means to be admitted. Indeed Captain Douhet himself offers a solution, namely to employ electrically propelled vehicles, taking their current, not from storage batteries carried by each vehicle, but from generators driven by internal combustion motors, and carried on vehicles especially designed for the purpose. The automobiles would be connected to the generators by cable, a series forming a convoy train. We have not space here to go into the details of the system, but we commend the whole treatment of the subject, which we have outlined above, to those engineers, who, while attacking the broad problem of military automobiles, may not have had all the difficult conditions fully and systematically placed before them.

Modern French Shipbuilding.

In the general extension of shipbuilding among the great commercial and manufacturing nations France has not been behindhand, as may be seen from a recent article in *Le Génie Civil* by M. A. Dumas, describing the latest vessels of the Compagnie Générale Transatlantique, "La Lorraine" and "La Savoie." These fine ships, which are, with minor unimportant differences, identical in dimensions and construction, are 177.5 metres in length (582.35 feet), and 18.28 metres beam (59.97), with a displacement of 15,410 tons and an indicated power of 22,000 h. p.

While these figures are not so great as those of some of the mammoth vessels of other countries, such as the Oceanic, the Deutschland, and others, yet they represent in other respects important advances in the art of shipbuilding for high-class passenger service.

The ocean record must lie with the largest ships, and these are of necessity barred from the Havre-New York route because of the limitations upon the dimensions for entrance at the French port, or for docking with the facilities there available. Under these limitations, therefore, it was impracticable to attempt to rival the dimensions of the largest ships of other lines, and consequently it was determined to devote attention to those even more essential elements, comfort, safety, beauty of finish and decoration, and such speed as should satisfy every personal and commercial demand.

In the account of these new French vessels given in the above mentioned article, the various details of construction and equipment are given in much detail, and some engineering features are of interest.

The total displacement, as above stated, is 15,410 tons, but of this great weight only 27 per cent. is variable load, the remaining 73 per cent. being fixed load, including hull, engines, boilers, etc. Of the variable load of 4,150 tons, fully 3,000 tons is that of the coal, leaving only 1,150 tons or about 7.5 per cent. of the total displacement for passengers and merchandise. A large part of this great increase in proportion of fixed load over earlier vessels is due to the demand for high speed. Thus in the case of the Champagne the variable load is 1,430 tons for a total displacement of 10,010 tons, or about 14 per cent. In increasing the speed from 17 to 20 knots, an increase of about 17.6 per cent. in speed, the useful carrying capacity has therefore been reduced about one-half. The total number of passengers of all classes which can be carried on the Savoie is 1,074, while on the Champagne it is 1,209, so that the large vessel actually carries a smaller paying load. With the exception of the *cabines de luxe,* however, the rates are the same for both vessels, but the apparent loss in revenue for the new vessels is fully made up in the higher economy of the more modern engines and machinery. This fact alone is a striking tribute to the direct relation of engineering to personal comfort and convenience, since passengers are carried across the Atlantic in a vessel far more luxurious and comfortable in its appointments than formerly at more than 17 per cent. higher speed, for the same price because engineers have succeeded in making their engines consume a little less fuel.

There is no remarkable innovation in motive power by which superior economy has been attained, this resulting simply from the general advance in design and construction which has taken place in the fifteen years intervening between the construction of the two vessels.

The Savoie is equipped with Scotch type cylindrical boilers, operating under forced draught, with a pressure of 170 pounds per square inch. The auxiliary machinery is supplied with steam from two boilers of the Belleville type, and much of the auxiliary work is performed electrically, the dynamos being driven by de Laval steam turbines. The main engines are triple expansion four-cylinder machines, there being two low-pressure cylinders, this giving constructive advantages besides permitting the employment of the Yarrow-Schlick-Tweedy system of balancing. Each engine is capable of developing 12,000 h. p., but in actual service about 9,000 h. p. is produced, or 18,000 h. p. for the pair. Independent condensers are used, and the piping is so arranged that any cylinder can be thrown out of service in case of necessity, and the three remaining cylinders run without it. In this as in every other mechanical detail, the best care and thought has been given to safety and to provision for every possible emergency.

This is not the place to descirbe the beauty of decoration and furnishing of the new vessels, except to say that the high standard of French taste has been well maintained.

The vessels were designed from the plans of the engineer-in-chief of the company, M. Daymard, and constructed at the yards of the company at Penhoët, Saint-Nazaire.

The Influence of Temperature on the Strength of Bronze.

About a year ago there was published by the *Verein deutscher Ingenieure* a report of important investigations upon the diminution of the strength of bronze by heat, these having been made by Professor Bach upon specimens furnished by the Imperial shipyards at Kiel.

We now have a further account of these researches, in a paper by Professor Bach in the *Zeitschrift des Vereines deutscher Ingenieure,* the investigations being upon a bronze of a somewhat different composition, furnished by Messrs. Schaeffer & Budenberg, of Magdeburg-Buckau. The bronze tested and reported upon in the present paper contained 87 parts copper, 8.7 tin, and 4.3 zinc, and at the atmospheric temperature of about 20 ° C. (68° F.) the resistance under tensile test was 2,431 kilogrammes per square centimetre (about 34,600 pounds per square inch), with an elongation of 15.2 per cent. and a reduction in cross-section of 17.4 per cent.

The apparatus in which the tests were made consisted of a vertical cylinder open at the top and provided with a bottom through which the lower head of the vertical testing machine passed and was secured. This cylinder was surrounded by a jacket of sheet metal provided with a circle of gas blowpipes, so that the heat was directed against the inner cylinder and the hot gases were kept in contact with it by the jacket. The inner cylinder was filled with palmine, having a boiling point higher than the upper limit of the test, and the whole was carried upon the lower head of the testing machine. The test piece was attached to the lower head, and an extension piece reached down from the upper head of the machine to connect with the upper end of the test piece. The latter was therefore completely immersed in the palmine, and the entire apparatus moved with the lower head of the machine, the slight motion being insufficient to affect the immersion of the test piece. In this way it was possible to maintain any desired temperature, within the experimental limits, and to observe the conditions of test very precisely.

It has been generally understood that copper and its alloys lose strength with increasing temperature, and indeed the experiments of the Franklin Institute about fifty years ago made this fact apparent. The tests of Professor Bach, however, show also the influence of heat upon extension and upon the reduction of cross-section, besides furnishing much more accurate quantitative data than was possible in the case of the earlier researches.

The data and results of the tests are tabulated very fully in the original paper, curves also being plotted to show the relations of temperature and resistance, but for these the reader must be referred to the original. The general results are as follows: Up to 200° C. (about 392° F.) the tensile strength was affected but little, the tests showing the resistance at 200° C. to be about 96 per cent. of the original value. Beyond 200° C., however, there is a rapid falling off in strength. At 300° C. (572° F.) the strength fell to 65 per cent. of the original value; at 400° C. (752° F.) it was but 45 per cent.; and at 500° C. (932° F.) the strength was but 28 per cent. of that at ordinary atmospheric temperatures.

These results are not greatly different from those previously obtained. They are slightly higher, but this is probably due to the somewhat smaller percentage of copper present in the alloy.

In regard to extension the results, while peculiar, confirm those previously obtained by Professor Bach in connection with the tests of pieces from Kiel. The ductility at 100° C. is slightly greater than at atmospheric temperatures, but with the increase of heat it fell rapidly, being but 39 per cent. at 300° C., and practically disappearing at 400° C., a similar change in reduction of cross-section appearing. Thus it is seen that not only does the strength of bronze diminish rapidly at temperatures above 200° C. (392° F.) but the ductility, one of the most important properties of copper alloys, falls off still more rapidly.

To quote the words of Professor Bach: The material tested, although an excellent bronze, as understood under ordinary conditions, is entirely unsuited for pipes or similar work for high or even moderately superheated steam.

It has generally been thought that the failures of copper and bronze pipes under modern steam pressures was mainly due to the weakness of the brazed seams, and numerous methods have been made to provide seamless copper pipes of large diameter for marine and similar service. It has even been attempted to produce pipes by processes of electro-deposition, with the view of obtaining an entire freedom from weakness of seams or brazing, but according to these most reliable experiments, the copper bronze itself loses so much of its strength and ductility as to be unfit for high pressure and temperatures. Since the use of superheated steam at pressures above 200 pounds is becoming general it is evident that copper alloys must be replaced by more reliable materials.

The Speed Regulation of Prime Movers.

One of the problems in connection with the conversion of reciprocating into rotary motion, as in the case of the steam engine, has been the control of the speed. With the early pumping engines of Watt and his predecessors this was a matter of small moment, so long as the water did not gain on the pumps or the engine dash itself to pieces against its buffers. The introduction of the centrifugal governor naturally accompanied the development of the rotatory engine, and with the application of steam power to spinning factories, flour mills, and other industries involving comparatively uniform rotary speeds, various improvements in speed regulating devices were evolved.

A new interest was directed to this question as the modern industry of electricity became of importance, and when every variation in engine speed showed in the flickering of the lights, it was evident that closer regulation must be maintained.

An interesting analysis of this problem, so far as electrical generating sets is concerned, is found in a paper presented before the *Verband deutscher Elektrotechniker* by Dr. Rudolf Franke, and published in a recent issue of the *Elektrotechnische Zeitschrift,* while the discussion of a special detail of the regulating mechanism, i. e., the fly wheel, is made by Herr Alexander Rothert in the *Zeitschrift des Vereines deutscher Ingenieure;* the two papers making a valuable contribution to this important branch of steam and electrical engineering.

Until recently the practice among steam engineers has been to express the variations in speed in the percentage of revolutions permitted from the rated speed. Thus an engine rated to run at 100 revolutions per minute was said to vary not more than 2 per cent. above or below its rating if the speed did not exceed 102, nor fall below 98 revolutions per minute; this being considered an excellent performance. It is evident, however, that an engine might fulfil these conditions and yet fluctuate very materially in angular velocity during a single revolution. Manifestly such a variation is undesirable for electrical machinery, and hence it has become necessary to study the regulation of engine speeds from an entirely different standpoint than formerly.

In order to examine this question intelligently Dr. Franke has devoted his attention to the construction of devices for recording the fluctuations in engine velocity, and having accomplished this end he proceeds to discuss the results obtained by their use.

When a reciprocating engine maintains a uniform number of revolutions per minute, the angular variations appear in a periodical form. It is therefore possible to consider the motion of the engine shaft as composed of two elements, one the continuous uniform number of revolutions per unit of time and the other the vibratory variations from uniformity per revolution or multiple thereof. It is these vibratory variations which it is desired to record and study, with a view to their modification or elimination.

If we can imagine the actual velocities to be taken as ordinates and the intervals of time as abcissas we shall obtain a line composed of short alternate waves representing the angular variations, the whole line also undulating in accordance with the variations in the number of revolutions per minute. The latter undulations represent the variations in load under the corrective action of the governor, and with modern governors they can be kept within very close limits. The periodical variations are entirely independent of the governor and are not produced by the changes in loading, but must be sought for elsewhere. Their origin is found partly in the variations in impulses upon the crank and partly upon the elastic periodicity of the members which communicate the power to the flywheel, including the torsion of the shaft, the elasticity of the steam itself, and similar influences.

Dr. Franke describes a number of devices which may be employed to record automatically the angular variations, some of them being very ingenious. Those which may be called strictly mechanical depend for their action upon a differential connection between the engine shaft and a heavy rotating fly wheel, the engine shaft gaining or losing upon the fly-wheel which it drives through the differential connection. This gaining and losing can readily be transferred to a recording drum, showing the vibrations in angular velocity. An optical device is also described, in which a beam of light is thrown upon a perforated revolving disk driven by the engine shaft and possessing all its variations in speed. After passing through the perforations in the rotating disk the light falls upon a mirror revolving uniformly at a high velocity, and the spot of light thus thrown upon a traveling band of paper appears as a sinuous line, which, if desired, may be fixed photographically.

The importance of investigating this side of the subject appears especially in connection with the parallel running of alternators, in which it is desirable to secure synchronism so far as practicable. The oscillations which appear in such cases are often due to variations in angular velocity of the engines by which the alternators are driven.

The best method of reducing the amplitude of the variations depends upon circumstances. Thus the indiscriminate increase of fly-wheel weight may do more harm than good, since any variation in the loading of one machine may be sluggishly followed by the other because of the great inertia to be overcome. When the fly-wheel is very heavy it also renders the motion less sensitive to the action of the governor, especially in the case of automatic engines. The whole problem should be taken under consideration in the original design of the engines, and the nature of the valve gear and the distribution of both the reciprocating and rotating masses should be undertaken in view of the work to be done. The coefficient of fluctuation, to use Rankine's term, which has ordinarily been taken as 1/100 as an extreme, should, according to Dr. Franke, be taken as not greater than 1/200 for engines driving alternators running in parallel, or indeed for electric generators in general. In any case there is little doubt that the periodical angular variations in speed occurring during each revolution are of as great importance as the total speed variations themselves.

A Study of Bridge Deflections.

Among the numerous valuable papers presented at the Mechanical Congress at Paris was one by M. Rabut, Chief Engineer of the Ponts et Chaussées, upon the experimental study of bridge deflections. This paper, together with the discussion is now made generally accessible in the pages ot the *Revue Générale des Chemins de Fer,* and will be found to contain much of interest.

It is not unusual to determine the total deflection of a bridge-girder or truss under a maximum loading, but M. Rabut goes much further, and employs an automatic recording device, which enables not only the extent but the duration, and general nature of the deflections to be obtained in form for permanent study and preservation.

The design of such a recording device is simple, but its construction involves a number of minor details which must be considered if satisfactory results are to be obtained. In the various forms of apparatus suggested by M. Rabut, and made by such accomplished mechanicians as Bourdon, Usteri, Schroeder van der Kalk and Kist, the deflections are multiplied by levers, and recorded upon drums moving with a determinate velocity, so that the time-sequence of the deflections is recorded on a scale sufficiently great to be clearly intelligible.

Without going too fully into the details of the method and apparatus, it will be of interest to examine some of the results which are attained.

When a bridge is subjected to a continual traffic consisting of a variety of loads and impacts, it is in a continual state of tremor. This is the case with the city bridges over which is pouring the multitude of omnibuses, carts, wagons, carriages and foot passengers. In such instances the diagram is practically uniform, consisting of a definite number of vibrations per second, varying occasionally in amplitude, but sinusoidal in form, and representing, undoubtedly, the period of vibration of the span or beam, just as the string of a musical instrument has its note. This is clearly seen in the diagram made by the application of the recording instrument to the *Pont des Saints Pères* in Paris. The vibrations are seen to be regularly four every second, and are almost as uniform as those of a tuning fork. When a highway bridge is subjected to a heavy moving load, concentrated within a limited length, the action is clearly indicated in the diagram. Thus the passage of a heavy road roller over the *Pont J. F. Lépine* shows the manner in which the deflections increase in amplitude, and change in character as the weight moves across the span. The recording apparatus shows also very clearly the effect of a small number of men keeping military step. A diagram produced by the passage of 16 men in military step over the Lépine bridge at Paris shows a far greater amplitude in vibration than that produced by a heavy road roller, the period of vibrations remaining practically unchanged, although the amplitude was increased.

The effect of the passage of a railway train is naturally altogether different from that of the loads on a highway bridge. The sudden impact of the train is followed by a rapid recovery, and this again by successive undulations, gradually passing away as the train passes on. The periodicity of the bridge itself is practically lost in the heavy external forces and the extent and nature of the record depends upon the magnitude and suddenness of the impact.

M. Rabut gives a number of such diagrams, showing the effect of various speeds and loads, and his researches enable the action of moving loads on bridges to be studied intelligently.

REVIEW OF THE AMERICAN PRESS

Balancing Marine Engines.

Two papers were presented before the Society of Naval Architects and Marine Engineers at its recent meeting in New York, both treating of the important subject of the balancing of marine engines. One of these was by Naval Constructor D. W. Taylor, U. S. N., who first made public the method known by the names of Yarrow, Schlick, and Tweedy, and variously patented in different countries, while the other, although presented anonymously, is known to have been written by Rear Admiral George W. Melville, Engineer-in-Chief of the United States Navy.

Mr. Taylor's paper discusses the problem both from its theoretical and its practical side, considering the four-cylinder method, using unequal crank angles, and shows that the present state of the science is now such that, given an engine, it is possible to determine fully the unbalanced forces developed from it at any number of revolutions. In theory it is possible to balance perfectly any engine. In practice, however, so many weighty considerations, apart from those of balancing, must be taken into account that the design of correctly and satisfactorily balanced engines, which are satisfactory in other respects, is exceedingly difficult.

A ship vibrates just like any other elastic rod or beam, forming nodes and loops such as are studied in the science of acoustics. These vibrations are originated by the action of the unbalanced forces in the machinery, and the action of these forces is investigated mathematically by Mr. Taylor, taking first a single-cylinder engine, and then extending the equations thus obtained so as to include multicylinder engines. The resulting analytical expressions enable the resultant unbalanced forces to be computed for any system of cylinders at any point of the revolution of the shaft, but they are altogether too complicated to be of direct practical application. By the introduction of graphical methods, however, the examination may be very materially simplified, and made practically available. Having deduced methods which enable the unbalanced forces to be found, Mr. Taylor considers the possibility of reducing or extinguishing these forces. Considering the ordinary type of vertical engines, there are four conditions which must be fulfilled in a perfectly balanced engine.

First. As it revolves the combined center of gravity of the moving reciprocating weights must remain at a constant distance from the axis. When this is the case, there can obviously be no resultant inertia forces, and hence no external force caused by the motion of the reciprocating weigths.

Second. If we substitute for each moving reciprocating weight another one proportional to the product of the weight by its distance parallel to the shaft from a fixed point on the shaft axis, the center of gravity of this derived system of weights must remain at a constant distance from the axis as the shaft revolves.

When this is the case and the first condition is complied with, there can be no external couple due to reciprocating weigths.

Third. The center of gravity of all revolving weights must be in the shaft axis.

When this is the case, there can be no external couple due to reciprocating weights. ternal force due to revolving weights.

Fourth. If for each revolving weight we substitute a weight proportional to the revolving weight, multiplied by its distance parallel to the shaft from a fixed point on the shaft axis, the center of gravity of this derived system must be in the shaft axis.

When this is the case and the third condition is complied with, there can be no couple or moment from revolving weigths.

In applying the method to actual engines Mr. Taylor takes examples from various cruisers in the United States Navy, and constructs diagrams showing the arrangement of counterweights to close the polygons and complete the balance.

So far as the crank angles are concerned, the equal angles of 120 degrees give the best results with three-crank engines, but when four cranks are used it can readily be chown that equal angles are not the best. Instead, the cranks should be arranged so as to give the most uniform turning moment, and Mr. Taylor shows that when properly arranged, the four-crank engine gives practically the best arrangement practicable, both for turning moments and for balancing.

Space will not permit us to go into the detailed discussion of the methods of drawing the force polygons and the determination of the best crank angles, and for this the engine designer must be referred to Mr. Taylor's original paper. The whole discussion, however, is by far the most complete exposition which has yet been made of the modern method of balancing marine engines, and as such is a very valuable contribution to the literature of marine engineering.

The paper of Admiral Melville, while dealing with the same general solution, takes up another phase, and discusses another method oi accomplishing the same desirable result. After calling attention to the fact that the United States navy has not adopted the method of four cylinders and unequal crank angles, Admiral Melville proceeds to discuss the MacAlpine method of balancing. This method is intended primarily for engines with two cylinders, and consists in connecting the two piston rods to the opposite ends of a vibrating beam, the connecting rod also being connected to one end of the same beam. By a proper proportion of parts this arrangement gives perfect balance as regards reciprocating weights, and any unbalanced couples act athwartships instead of fore and aft, and are not likely to cause objectionable vibration. Since this gives a complete solution of the problem of two-cylinder balance, it can readily be applied to triple and quadruple expansion engines by doubling it, so that it becomes a perfectly general solution.

Admiral Melville goes very fully into the applicability and general advantages of the MacAlpine system, and maintains that he would not hesitate to run a properly proportioned and balanced engine on that system at speeds as high as 1,000 feet piston speed and 100 to 120 revolutions per minute.

The result of both of these papers is to place before the profession the practical methods of balancing marine engines so completely as to enable any designing engineer to make use of either system, so that there is no reason why excessive vibration, due to unbalanced engines, should be permitted.

Modern Piece-Work Methods.

Among the papers presented at the recent convention of the American Society of Mechanical Engineers may be noted that of Mr. H. L. Gantt, upon the bonus system of rewarding labor.

This system is based upon that of Mr. Fred. W. Taylor, and is as follows:

A card is made out, showing in detail the best method (so far as present knowledge goes on the subject) of performing each of the elementary operations on any piece of work, specifying the tools to be used, and setting the time needed for each of these operations as determined by experiments. The sum of these times is the total time needed to complete the piece of work. If the man follows his instructions, and accomplishes all the work laid out for him, as constituting his proper task for the day, he is paid a definite bonus in addition to the day rate which he always gets. If, however, at the end of the day, he has failed to accomplish all of the work laid out, he does not get his bonus, but simply his day rate. As the time for each detail operation is stated on the instruction card, the workman can see continually whether he is earning his bonus or not, and if he finds any operation which cannot be done in the time set, he must at once report it to his foreman. If, on careful investigation by the man making out the card, the workman's statement is found to be correct—that a portion of the task cannot be done in the time stated on the card—a new instruction card is made out, explaining the proper method of working, and allowing the proper time. It is of the greatest possible importance for the moral effect upon the men that errors in making out instruction cards should be as few as possible. A man must be allowed time only for what is stated on his card, and while a reasonable time must be allowed for each operation, he should fail to receive his bonus if time is lost from any cause whatever. (The foremen also receive, in addition to their day wages, compensation proportional to the number of their men who earn a bonus, and an extra compensation if all of their men earn their bonuses.)

The basis of this system is the differential piece-work plan of Mr. Taylor, with the bonus added, and is altogether removed from the old-fashioned method of fixing piece rates from the records of the total time it has taken to do a job.

It possesses an advantage over direct piece work in that it is more flexible and can be introduced with greater ease and under conditions where piece work proper would be impossible. When it is realized that proper piece work will, in many cases, produce at least three or four times as large an output as ordinary day work, the difficulties of putting directly on piece work men who have been accustomed to doing work in their own way and in their own time would seem to be, and generally is, extremely difficult. While the men who are on day work usually realize that they are not doing all they can do, when they are told that it is possible to do three or four times as much as they are doing they simply do not believe it, and it is very difficult to make them accept as just a piece rate founded on this basis; but a reward in addition to their day rate constantly held before them will finally be striven for by some one, and when one has obtained it others will try for it. In other words, if the instruction card is made out and a substantial bonus offered, time will do the rest.

Naturally the principal difficulty to be expected from such a system would be from the opposition or indifference of the men, but in practice it appears to work all right.

In making a comparison between the bonus system and proper piece work, it will be recognized at once that each has its advantages. If we have a thorough knowledge of all the conditions, and are able to introduce piece work, it is undoubtedly to be preferred; but we must remember that, aside from the injustice, there is nothing so demoralizing as cutting piece rates, and it is not only extremely difficult to make out proper piece rates, but it is still harder to convince men who have been accustomed to working by the day only, that it is possible for them to earn fair wages when proper rates are set. On the other hand, as the bonus is paid to men in addition to their day rate for performing the work in the manner and time called for by their instruction cards, they do not feel so hostile toward the innovation. These cards do not pretend to represent absolutely the best possible method, but the best method we can devise with the present state of our knowledge, and, while they may be changed as our knowledge increases, they are always intended to describe a method which is within the ability of a good man to reach. The difficulty of introducing such a system is far less than that of introducing direct piece work, for if workmen, having secured to them their day wages, are given such instruction cards, and a considerable reward is held out to them for doing the work in the manner and time called for in the instruction cards, they will gradually overcome their prejudice against following instructions, and finally attempt to perform some of the operations in the time set. Having performed a few of these operations, and finding out that the card represents a fair and reasonable set of instructions, they will, in a short while, conclude that they might as well have the extra pay, and gradually learn to follow the whole card. This has been the experience of the writer, and he was surprised to find out how quickly the men overcame their prejudice. Before the introduction of the bonus, no man was willing to ask somebody else to hurry in order that he might get his work done, for the man spoken to would resent such a request as an insult. Men seldom complained to a foreman that they were being interfered with, but simply sat down and waited, and would sometimes wait for a crane by the hour. Now all are up in arms against anybody who does not serve them almost instantly.

The whole idea of the remuneration of labor, when treated as indicated in Mr. Gantt's paper, is that of individualism, as compared with collectivism under the old system. According to the trades union idea, the men are considered as a whole, and generally as opposed to the employers, also considered as a whole. Under the new idea each man is practically in business for himself, and his fellow workmen, while not his competitors, so far as his own work is concerned, are not his partners, but are also independent business men. The method conduces not only to independence on the part of the men, but also to their general elevation, and especially does it tend to sort out the capable and skilful men, and relieve them from the burden of their less willing or less competent companions. In the long run it must also tend to the general prosperity of the community in which they live, since it permits the establishment for which they are working to command a larger market because of its more efficient management, thus increasing the demand for their labor as well as the price which is paid for it.

Hydraulic Problems.

We have frequently referred in these columns to the peculiarly elusive nature of the problem of the determination of the velocity of flowing water, and notwithstanding the study which has been given the subject it is evidently far from being exhausted.

In a paper presented before the American Society of Civil Engineers, and published in the *Proceedings* of that society, Mr. Charles H. Tutton discusses the question of the flow of water, taking into account the influence of viscosity. It is well known that in a flowing stream the maximum velocity is found, not at the surface of the water, but at some point below the surface, but no satisfactory explanation has yet been offered for this phenomenon.

The usual method employed in text books is to assume that the mass of liquid is a body of invariable volume, sliding down an inclined plane under the influence of gravity, just as a solid weight would do. This method gives correct results only in the case in which the axis of the curve which represents the curve of mean velocity is found in the free surface, a state of affairs which seldom or never exists. As a matter of fact the total resistance to the motion of the water is composed of two entirely different yet mutually dependent elements, one being the so-called friction along the bed and sides of the stream, while the other is composed of the internal resistances in the water itself, or the so-called viscosity.

Examining the conditions of flow according to Bernouilli's theorem, Mr. Tutton shows that the flow in a liquid is really caused by the pressure on the end section, which pressure is due to a head of liquid measured by the sine of the slope, and which acts uniformly over the section and normal in direction to the line of action of gravity.

The usual treatment for viscous resistance, following the method of Navier, results in a velocity curve of the form of a parabola. Mr. Tutton, however, by examining the frictional resistances between elementary filaments of the liquid, shows that the curve of velocity is an ellipse, the semi-axes of which are the maximum velocity and the distance of that maximum velocity from the bed of the stream. From this treatment he develops equations for the computation of the mean velocity and for the depth at which this mean velocity may be found, and computes a table of the elements of elliptic head, momentum, and kinetic velocity.

As Mr. Tutton well remarks, it appears natural that the branches of the curve of velocity should be tangent over the point of maximum velocity, and that it should terminate tangentially to the bed. It would seem that a curve abruptly cut off at the bed should slip along it. It is hard to conceive the fluid torn apart as would be required by parabolas, hyperbolas, etc., and the ellipse seems to be the proper curve.

So far as the fact of the location of the point of maximum velocity beneath the surface is concerned, it is altogether natural that it should be so placed when we consider the impelling force of the stream to be the slope head acting as a pressure over the end section of the prism. The prevailing notion appears to have been that somehow the upper surface of the water slid along over the layers beneath it, and should have the maximum velocity, whereas the law enunciated by Mr. Tutton shows that the entire prism is practically pushed along by forces acting over its entire section, and it is not to be expected that the maximum velocity should be on one edge of this prism, so to speak.

The paper contains a mass of valuable

information concerning the theory of the flow of water, and while it is to be expected that the treatment of the subject will elicit much discussion and criticism, it appears to open up a line of study which should yield very fruitful results in this much debated field of practical engineering.

The Mining Engineers in Mexico.

Society conventions are not such uncommon affairs as to demand especial notice in most instances, but the recent visit of a party of the American Institute of Mining Engineers to Mexico was such a success that some brief notice of it is appropriate. From a very complete account of this trip published in the *Engineering and Mining Journal* a brief abstract is here made, and interested engineers are referred to the fuller account for details.

Mexico has long been considered the pioneer mining country in America, and for 160 members of the national mining society to make a special trip through its most famous mining regions, escorted and welcomed by the eminent leaders in science and industry of the different localities, was an event which must yield important results.

Although Mexico has been considered as a great silver producing country for centuries, and is rapidly increasing its gold production there are other minerals which must also be considered when its mineral wealth is discussed. Copper is rapidly becoming of great importance, and to the mines at Boleo, Nacosari, and elsewhere, it it believed that others will soon be added. Coal, iron, manganese, etc., form much of the mineral wealth of Mexico, and to these it is not improbable that fuel oil may possibly extend from Texas into Mexico.

As Mr. Olcott, the president of the American Institute of Mining Engineers, said in his response to the address of welcome of Ing. Don Augustin Aragon, the Minister of Industrial Encouragement, the United States, at the time of the development of the Comstock lode and other mines of early date, turned to Mexico to obtain skilled miners. For the treatment of ores the pan mills of the Washoe district were but the patio process of the Mexicans with the arrastras made of iron. The whole nomenclature of western mining in the United States is based on Spanish terms, and on the one point in which Mexican practice was departed from, that of mining law, the change was for the worse and not for the better.

The technical papers presented at the convention related naturally to subjects belonging mainly to Mexican methods, and the more important must be reserved for notice hereafter, and the main importance of the meetings must be considered as relating to that which was seen rather than heard. Mexico has been so isolated, so dependent upon its own resources, and has made such good use of its great natural wealth that it could teach the visitors much of value.

Not the least important result of this convention will be the close relations and better understanding of the engineers of the two republics as to each other's materials and methods, a result which will be strengthened by the visits of Mexican engineers to the United States which must follow the courtesies shown and acquaintances made at the Mexican convention of the American Institute of Mining Engineers.

Endurance Tests of Automobiles.

We have reviewed at length in another place the subject of automobiles for military service, showing the severe conditions which must be met before any practical results of value can be expected in that service. As bearing upon this subject we may examine the actual performance of some of the leading machines in the recent run from New York city to Rochester, taking as the basis of our comments the reports given very fully in the *Automobile Magazine*.

As the distance actually traversed was nearly 400 miles, and as the roads, while by no means good, were better than the average in the United States, the results may be considered as affording good practical information. Eighty vehicles started, and but forty-one arrived in time for record by the control, and instructive lessons may be drawn both from the successes and from the failures, especially from the latter.

The general condition of the automobile question at the present time is well expressed, so far as endurance is concerned, by the remark in the articles above referred to: "It would be impossible to have seventy or eighty vehicles go on any kind of a run lasting over a day, without some needing overhauling to a more or less degree after the first one hundred miles." As a matter of fact practically all the machines needed a great deal of overhauling, although nearly all of them had been most carefully examined and prepared for the trials. No restrictions were placed upon the amount of repairing which the contestants were allowed to make, and no limitations upon the number or nature of spare parts carried or provided. As a result some of the contestants had a large supply of spare parts sent on by train, or carried in supply wagons, and some had expert mechanics who traveled by train and worked at night, putting the vehicles in repair for the next day's work. Thus the 30-horse Panhard vehicle which arrived first at the destination doubtless maintained its record by the manner in which provision had been made for repairs and renewals. One mechanic rode on the machine with the driver, and two more were sent ahead to be ready at each of the controls, with a large box of tools and materials, the two men going over the vehicle every night, and putting it in perfect shape for the morning's journey. So far as endurance is concerned, this practically made the trials single day's runs, each properly being a fresh start with a fresh machine.

As in previous tests elsewhere, the weak points in the machines were elsewhere than in the motive power. Some difficulty was experienced with the electric ignitions in wet weather, but this is a detail which can be readily remedied. The principal defects appeared in the running gear. Wheels, tires, and axles were the chief sources of trouble, and this is only what might have been expected.

To propel a vehicle by turning the wheels from the hub is a far different thing than for the wheels merely to sustain the load and be drawn by horizontal forces acting on the axle. When to this is added the use of large pneumatic tires, with all their possible ailments and weaknesses, it will be realized that here is the place for improvers of automobiles to direct their energies. If these are the facts with pleasure or touring vehicles, how much more important do they become for vehicles for commercial or military service. Speed is all very well, but durability comes first, and in practice it is durability on rough roads, in wet or slippery weather, up heavy grades, and under only average conditions, rather than durability on the parkway or the race track, which must be attained.

The automobile question is one which is in the hands of the engineer to solve, and he has solved only a part of it. The motive power is all right. Improvements will come, and will be welcomed, but the present steam and internal-combustion motors are successes. The mistake of following the lines and construction of horse-drawn vehicles in the design of the running gear is one which, already in process of correction, must be rectified completely. This portion of the work is as much of an engineering problem as is the motive power, and it is in the hands of the engineers for solution. Probably improvements will come as a growth of the experience of such trials as that which has been referred to, but much of it must follow the general experience of users as transmitted to the manufacturers. At the same time there is no reason for following lines which are radically wrong, in order that they may be corrected by experience alone, and it is to be hoped that to the present growing list of makers of automobiles there may soon be added some who will forget that carriage builders are in existence or that horses ever lived, and who will make machines on true mechanical lines throughout, machines which will not need portable repair shops as inevitable accompaniments.

Electricity at the New York Navy Yard.

The machine shops of the New York Navy Yard were destroyed by fire in the spring of 1899, and with the necessity for the entire rebuilding came the question of the introduction of electric driving. This has been undertaken in very complete style, and the new plant is now in operation and is very fully described in a paper by Mr. F. N. Kollock, Jr., in the *Journal of the American Society of Naval Engineers*.

After a careful examination of the relative merits of the alternating and direct-current systems, the decision was made in favor of the former. This decision was made in view of the superior advantages of alternating currents for transmission over considerable distances, transformers being used at the points of application.

The new buildings include a machine shop, 350 by 130 feet, an erecting shop, 252 by 130 feet, and a boiler shop, 300 by 96 feet, all the buildings being fire-proof and all equipped with modern tools. The power used throughout the steam engineering shops, with the exception of that for cranes, is furnished by alternating-current motors directly connected to the larger machine tools, and belted to countershafting for driving the smaller tools. There are three cranes in the machine shop and three in the erecting shop, these ranging from 10 to 40 tons capacity, all operated by direct-current motors, rotary transformers being used to enable these to derive their current from the main plant.

The generating plant consists of three generating sets, with vertical compound McIntosh-Seymour engines and Westinghouse alternators, the engines being of 630 h. p. each at 136 revolutions, and the alternators having 25 periods per second, two-phase, at 220 volts pressure. The generators have a guaranteed efficiency of 94½ per cent. at full load, and 84 per cent. at ¼ load. Full details of the construction of the generators are given in Mr. Kollock's paper.

The motors range from one of 200 h. p., driving a large air compressor, down to motors from 1 to 30 h. p., these being alterating current two-phase motors for driving the various machine tools and countershafts, there being 60 such motors in all.

The entire plant, while designed in accordance with the most advanced ideas, can in no wise be considered as experimental. Standard apparatus is used throughout, making duplications or possible renewals very easy, and the plant is similar to others which have given excellent satisfaction in actual service.

It is encouraging to see a government plant thus take a place in the front rank of modern equipment methods, refuting the accepted idea that conservatism invariably prevails in such establishments; and where such progressive ideas obtain in official departments we may expect to find private shops following close on their heels.

The Distribution of Electrical Energy.

At a recent meeting of the American Institute of Electrical Engineers there was a "symposium" on the distribution of electrical energy. Eight papers were read by as many authors, each casting the light of his own experience on the subject, which was thus illuminated on all sides.

The first paper was on the "Distribution of Electrical Energy in Large Cities," by Mr. Louis A. Ferguson, who gave an account of the actual conditions existing in Chicago.

"With the trend of modern times towards consolidation of lighting, power and transportation properties, the system of distribution of electrical energy, in large cities especially, is daily becoming a more important question, involving many perplexing problems and considerations. Were one given the problem of determining the system in an imaginary city fully developed in its business and residential portions, its growth matured and freed from the pioneering and bad engineering of the promotion days of electricity, the question would be a comparatively easy one." But it is "a condition and not a theory which confronts us," and the modern consolidators usually find it advisable to adapt their engineering to existing conditions, abandoning as little as possible the investment made by the companies which they absorb. And not only what has been done in the past must be considered, but also the possible development of the future, so that many conflicting quantities enter into the general problem.

"The developments of the last few years have determined conclusively that the old method of installing a multiplicity of steam generating stations scattered throughout the city and furnishing electricity for lighting and power is no longer advisable. We find the more progressive companies abandoning their smaller plants as generating stations, converting some into sub-stations and centralizing the generation of electrical energy in one or two large power stations located preferably on a water front and having direct communication with two or more railroads bringing coal from different sections of the country." Water and coal facilities being equal, the main power house should be as near the center of distribution as possible, the cost of land being a secondary consideration. "In any new principal station the generators should be of the same frequency, even if it is advisable, owing to local conditions, that one or more be double-current machines. It is always conducive to economy, flexibility of operation and minimum initial investment that all the generators be arranged for parallel operation.

"The determination of the class of current we shall generate depends entirely on the class of current we distribute. Considering the question for a large city from the broadest standpoint, and judging by experience with the advantages and limitations of both forms of distribution, I would recommend direct current for the lighting and power work of the strictly business and city residential districts, and alternating current for the less closely built residential districts with their local business incident thereto, as well as for the actual suburban territory of the city."

An analysis of the lighting and power output (not including railways) of Chicago central station companies where this method of distribution is followed, shows that of a total maximum output of 22,500 kilowatts, over 20 per cent. is by 60-cycle alternating distribution over a territory of approximately 58 square miles and nearly 80 per cent. is by direct current distribution over a territory of only 10 square miles.

"The growth of the business of the company (except in the Southern district, where a modern 60-cycle station operates) is being provided for by 25-cycle rotary sub-stations, and all direct current generating apparatus will be superseded as it wears out or becomes obsolete, by 25-cycle rotary sub-station distribution in one low tension district. As the outlying residence districts become more general consumers of electricity, they are changed over to low tension direct current, and all new development in the Northern and Western districts is supplied by motor generator sets receiving 25-cycle current from the main generating station and delivering 60-cycle current to the distribution lines."

The importance of the power business, which amounts to over thirty per cent. of the total station load of the Central District, led to the adoption of the three-wire direct current system for distribution in this business and residential section. Storage batteries are largely used in this district, there being three batteries in the Adams Street sub-station, having a combined capacity at the eight-hour rate of 66,000 ampère hours, and smaller batteries in three of the rotary sub-stations in the residence district.

Storage batteries are desirable wherever the service of the central station is important. They may be used in various ways: in the central station itself when it is located at the electrical center; at the center of distribution for discharging during the peak of the load; as auxiliaries in the rotary converter sub-stations. But their greatest value is in their ability to carry the system through an emergency which comes, as a rule, with very little warning.

In the outlying Northern, Western and Southern districts of Chicago, 60-cycle alternating current is distributed by a four wire, three-phase system. This current is generated directly at a principal station in the Southern district, and in the Northern and Western districts at motor-generator sub-stations, the motor side being fed by 25-cycle three-phase current from the Harrison Street main station.

Mr. Charles F. Scott, in his paper on "Alternating Current as a Factor in General Distribution for Light and Power," says that at present the only question is between alternating current alone, and alternating generation with direct current distribution. He favors the former method but he admits "that there is no ideal system and no panacea plan which can be universally applied. Existing and local conditions, special requirements and the relative importance of the various classes of service to be rendered must all be taken into account in determining what will be adequate in an individual case."

This is a fair general conclusion to be gained from all the papers which were presented at the meeting, but one or two points seem to be pretty well determined upon: Three-phase current should be generated at large central stations. For general purposes in outlying districts this should be distributed as three-phase or simple alternating current at pressures to suit circumstances; while in the central portions of cities and other places where there is a large local demand, as well as for railway purposes, there should be rotary converter sub-stations from which direct current is distributed.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCES IS THE ENGINEERING INDEX"

The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) When published,
(6) Where published.

We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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BRIDGES.

Approach.

The Rankin Bridge. Illustrated detailed description of a bridge across the Monongahela River, at Rankin, Pa., notable for the massive construction required, and for the special design of the river end of the south approaches. 4500 w. Eng Rec—Nov. 16, 1901. No. 44405.

Bascules.

Some Old Examples of Bascule Bridges. K. Hellenthal. An illustrated description of bridges of this type, or based on similar principles, built before the patents for the bascule bridges were issued. Ill.

1500 w. Jour W Soc of Engrs—Oct., 1901. No. 44156 D.

Bridge Design.

"Monumental" Engineering. Montgomery Schuyler. A critical discussion of the designs for the Memorial Bridge across the Potomac from Washington to Arlington. Ill. 7700 w. Archt Rec—Oct., 1901. No. 44117 C.

The Architectural Treatment of Bridges. Illustrated extracts from *The Builder,* giving suggestions for designing piers and spandrel facings of flat masonry arches. 2200 w. Eng Rec—Nov. 2, 1901. No. 44148.

Brooklyn Bridge.

The New York and Brooklyn Bridge. Review of the report of expert engineers appointed to make an examination of the bridge. 3000 w. Engr, Lond—Nov. 1, 1901. No. 44309 A.

Concrete Arch.

New Concrete Arch Bridges at Niagara. Orrin E. Dunlap. Illustrated description of the bridges built at Niagara Falls to connect the mainland and Goat Island. 1000 w. Sci Am—Nov. 23, 1901. No. 44467.

Continuous Girder.

A Diagram for Finding Pier Moments on Continuous Spans. C. E. Young. Diagram with explanation, illustrated by examples. 900 w. Eng News—Nov. 14, 1901. No. 44387.

Draw-Bridge.

New Street Railway Draw-Bridge at New Bedford, Mass. William F. Williams. An illustrated detailed description of this bridge and its operation. There is a double-track electric railway line the entire length of the bridge. 1800 w. St Ry Rev—Nov. 15, 1901. No. 44463 C.

East River Bridge.

Building the Approaches of the New East River Bridge. Brief description with illustration of the new bridge across the East River, New York. 1000 w. Sci Am—Nov. 16, 1901. No. 44365.

Masonry Arches.

The Design and Construction of Masonry Arches. William D. Pence. Discusses the masonry arch from a practical point of view, and briefly considers the concrete-steel construction. 5000 w. Indiana Engng Soc, 1901. No. 44417 D.

The Rockville Stone Arch Railway Bridge. Illustrated description of a 4-track masonry bridge, 3,820 ft. long, having 48 arches of 70-ft. span. Explains the design and method of construction. 1700 w. Eng Rec—Nov. 9, 1901. No. 44210.

Melan Arch.

Melan Arch Park Bridges at Washington, D. C. W. J. Douglas. Illustrates and describes the construction of two concrete-steel bridges built for the U. S. government, with particulars concerning the work, and the subsequent cleaning made necessary by discolorations. 2400 w. Eng News—Oct. 31, 1901. No. 44108.

Redheugh Bridge.

The Redheugh Bridge. Two-page plate and other illustrations of the details of the piers, approach spans, and roadways of the structure, with description. 1200 w. Engng—Nov. 8, 1901. No. 44337 A.

Renewal.

A Railway Bridge Renewal. Illustrates and describes the removal of a bridge, where a railway intersected a railway, with as little interruption of traffic as was possible. 1600 w. Engr, Lond—Nov. 15, 1901. No. 44623 A.

Shop Work.

Modern Practice in Bridge Shop Work. W. H. Pratt. A brief paper on the development of these shops, with discussion. Ill. 1200 w. Jour W Soc of Engrs—Oct., 1901. No. 44155 D.

Superstructure.

Superstructure of the Interprovincial Bridge, Ottawa. F. P. Shearwood. An illustrated description of the superstructure of the bridge recently erected at Nepean Point, Ottawa. Plates. 3200 w. Can Soc of Civ Engrs—Adv. proof—Nov. 21, 1901. No. 44633 D.

Suspension.

A Stiffened Suspension Bridge on a Steep Incline at the Westport-Cardiff Coal Company's Mine, New Zealand. Thomas Harold Rawson and George Herbert Broome. Presented to the Inst. of Civ. Engrs, of Gt. Britain. Describes the conditions which only permitted the most economical design consistent with required strength, and rapid erection. Illustrated description. 1600 w. Eng News—Nov. 14, 1901. No. 44388.

Testing.

Experiments on French Metal Bridges. Description of experiments on girder and truss bridges indicating that the distribution of stresses in the various members is different from the usual assumptions made in engineering designs. 1700 w. Eng Rec—Nov. 9, 1901. No. 44209.

CANALS, RIVERS AND HARBORS.

Dredging.

Heavy Dredging with Light Machinery at Havana. A. H. Weber. A description of heavy rock and clay excavation with machinery too light for the work, causing delays by break downs and large sums for repairs. 1100 w. Eng Rec—Nov. 23, 1901. No. 44495.

Dry Dock.

The Caisson at the Kiel Drydock. Illustration, with brief description of a huge caisson costing about $250,000. 450 w. Sci Am Sup—Nov. 2, 1901. No. 44099.

Floating Dock.

Floating Dock for Khartoum. Drawings and description. 1400 w. Engr, Lond—Oct. 25, 1901. No. 44137 A.

Harbor Cranes.

Erection of 120 Ton Shears at the Port of Havre (Mise en Place d'une Bigue de 120 Tonnes dans le Port de Havre). Ch. Dantin. Illustrated description of the powerful new shears recently erected at Havre, with photograph showing the method of erection. 1800 w. 1 plate. Génie Civil—Nov. 9, 1901. No. 44508 D.

Floating Crane for Rio de Janeiro (Schwimmender Mastenkrahn für den Hafen von Rio de Janeiro). H. Frahm. Illustrated description of 80-ton floating shears built for the Brazilian government. 1200 w. Stahl u Eisen—Nov. 15, 1901. No. 44543 D.

Harbor Works.

The New Harbor Works at Dover. Describes the works under construction, giving plan and chart and explaining their importance and the advantages to be secured. 3400 w. Nineteenth Cent—Nov., 1901. No. 44322 D.

Inclined Plane.

Inclined Planes for Canal Locks (Frogschleusen auf Geneigten Fahrbahnen). Jaroslav Gröger. With especial reference to the overcoming of differences of level on the Danube-Moldau Canal. Two articles. 10,000 w. 1 plate. Zeitschr de Oesterr Ing u Arch Ver—Nov. 19, 1901. No. 44528 each B.

Land Protections.

The Practical Building of Lowland Protections. Percy H. Wilson. Abstract from a thesis presented to the Civ. Engng. Dept. of the Univ. of Penn. The practical building of banks with their protections, with sketches showing detailed plans of constructions in each class, noting their advantages and disadvantages. 7300 w. Pro Engrs' Club of Phila—Oct., 1901. No. 44431 D.

Land Reclamation.

The Reclamation and Irrigation of the Kistna Delta, India. An illustrated account of this work, abstracted from an article by George T. Walch, published as a government document at Madras. 3300 w. Eng News—Nov. 7, 1901. No. 44280.

Lighthouses.

Building the New Beachy Head Lighthouse. Harold J. Shepstone. Illustrated description of a lighthouse erected on a wave-washed rock, 550 ft. from the cliffs, as the lighthouse on the promontory is frequently obscured by fogs. It will be, when completed, one of the finest lighthouses on the English coast. 1800 w. Sci Am—Nov. 9, 1901. No. 44229.

Steel Lighthouse Construction. Waldon Fawcett. Relating to changes proposed in these structures, providing the United States government decides to erect additional towers of this type. Ill. 1600 w. Am Mfr—Nov. 21, 1901. No. 44480.

Mississippi.

Bank Revetment on the Lower Mississippi River. Charles Le Vasseur. Read before the Memphis Engng. Soc. Illustrates and describes the revetment work; the making of the mattress, the launching, etc. 2700 w. Eng News—Oct. 31, 1901. No. 44107.

Nicaragua Canal.

The Nicaragua Canal Project S. D. Webster. A critical discussion of a paper by W. K. Kavanaugh, read at the Industrial Convention at Philadelphia. 4500 w. St. Louis Ry Club—Nov. 8, 1901. No. 44636.

Protective Works.

Proposed Permanent Protective Works for Town of Dera Ghazi Khan. Specification of work which is not only to stop the invasion of the river Indus, but cause it to restore the land washed away. Ill. 2000 w. Ind and East Engr—Oct., 1901. No. 44499 B.

CONSTRUCTION.

Building Construction.

Reconstructing the Morse Building, New York. Illustrated description of the methods employed in building an 8-story steel cage structure on top of one of the oldest office buildings in the city. 3100 w. Eng Rec—Nov. 2, 1901. No. 44146.

Dome.

The Students' Hall Dome, Columbia University. Illustrates and describes the construction of a tile dome 48 1/3-feet in diameter inside, with a total rise of about 68 feet. It is of the Guastivino construction. 700 w. Eng Rec—Nov. 23, 1901. No. 44497.

Excavating.

Steam Shovels for Trench Excavation. Illustrated description of work upon which this method of excavation has been employed. 1400 w. Eng News—Nov. 7, 1901. No. 44277.

Fireproofing.

The Protection of Iron Construction Against Fire (Die Hulfsmittel zum Schutze des Eisens gegen Feuersgefahr). M. Gary. Describing the fireproofing methods shown at the Berlin exposition, 1901. 2000 w. Stahl u Eisen—Nov. 1, 1901. No. 44540 D.

Floor Tests.

Fire and Weight Tests of Columbian Fireproof Floor; Boston, Mass., July, 1901. Frank P. McKibben. An illustrated account of tests made to demonstrate the capacity of this system when under heavy loads to resist the action of fire and water. 900 w. Eng News—Nov. 21, 1901. No. 44473.

Weight Tests of Rapp Floor Arches. Illustrated description of 6, 10 and 12 ft. arches of brick on light iron frames, tested with loads up to 3,000 lbs. per sq. ft. without serious deflection. 400 w. Eng Rec—Nov. 9, 1901. No. 44212.

Framework.

Metallic Construction (Constructions Métalliques). An examination of the stresses in framed structures with especial reference to roof trusses. 1500 w. Revue Technique—Oct. 10, 1901. No. 44549 D.

Girders.

Heavy Girders in the Union Club House. Illustrated description of the construction, especially the heavy girders. 1300 w. Eng Rec—Nov. 16, 1901. No. 44410.

Piers.

An Austrian Investigation of Masonry Piers. Abstract of the report of tests on the compressive resistance of masonry, made by order of the Austrian Soc. of Engrs & Archts. Ill. 3300 w. Eng Rec—Nov. 23, 1901. No. 44493.

Pile-Driver.

A New Pile Driver, Boston & Maine R. R. Illustrated description of an exceedingly strong and serviceable machine showing modern improvements. 1000 w. Ry & Engng Rev—Nov. 9, 1901. No. 44,-270.

Reinforced Concrete.

Concrete-Iron Construction (Ueber Betoneisen Konstruktionen). S. Rappaport. A discussion of the stresses in floor construction, showing the lateral strains induced upon the walls of the building. 2000 w. Schweizerische Bauzeitung—Nov. 2, 1901. No. 44557 B.

Recent Examples of Concrete-Iron Construction (Neuere Bauweisen und Bauwerke in Beton und Eisen). F. v. Emperger. With illustrations of pier and wharf construction. Serial. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 25, 1901. No. 44527 B.

Roads.

Can Present Standard Road Specifications Be Improved. Halbert Powers Gillette. Calls attention to certain clauses in the "standard specifications" for macadam road-work as practiced in New York and Massachusetts. 3800 w. Eng News—Nov. 7, 1901. No. 44279.

Suggestions for Road Building in Tennessee. Hunter McDonald. Extracts from a paper presented to the Tenn. Good Roads Convention. Discusses gradients, materials, drainage, etc. 1500 w. R R Gaz—Nov. 15, 1901. No. 44396.

Sanitary Buildings.

Sanitary Architecture. A lecture on design, materials, buildings, workmanship and supervision at the Carpenters' Hall, London, by Mark H. Judge. 2800 w. Archt, Lond—Nov. 8, 1901. No. 44323 A.

Skeleton Buildings.

The Steel Work in Skeleton Buildings. William Copeland Furber. Discusses rust prevention and fireproofing. 2000 w. Ins Engng—Nov., 1901. No. 44122 C.

Tunnels.

Progress of Construction of the Rapid Transit Tunnel. An outline of the satisfactory progress made on the New York tunnel, with map and editorial. 3000 w. Sci Am—Nov. 2, 1901. No. 44095.

Some Methods of Construction of the Rapid Transit Subway. Views taken at various points, illustrating methods and showing progress, with description. 1300 w. Sci Am—Nov. 9, 1901. No. 44230.

The Construction Works of the Simplon Tunnel (Die Bauarbeiten am Simplontunnel). S. Pestalozzi. Describing especially the auxiliary works in connection with the tunnel, including the water-power plants, etc. Serial. Part I. 2000 w. Schweizerische Bauzeitung—Nov. 2, 1901. No. 44556 B.

Tunnelling. Review of a practical treatise by Charles Prelini, with additions by Charles S. Hill, placing on record the distinguishing characteristics of tunnelling methods practised in the present day. 5600 w. Builder—Nov. 9, 1901. No. 44341 A.

Work on the Simplon Tunnel. Comments on the engineering work and the advantages of this route through the Simplon Pass, over the Mt. Cenis and St. Gothard. Ill. 2000 w. Sci Am—Nov. 16, 1901. No. 44368.

See also Railways and Tramways, Permanent Way.

MATERIALS.

Asphalts.

Asphalts—Their Sources and Utilization. T. Hugh Boorman. Discusses the various kinds of asphalt and their adaptability for different methods of construction. 1800 w. Archts & Build's Mag—Nov., 1901. Serial. 1st part. No. 44,-175 C.

Cements.

American Portland Cements. S. B.

Newberry. A brief study of the manner in which American engineers have solved the chemical and mechanical problems of adapting its manufacture to American conditions. 2300 w. Indiana Engng Soc—1901. No. 44415 D.

Cement for a Modern Street. Dr. S. F. Peckham. Briefly describes the different cementing materials experimented with in the construction of concrete foundations, giving the details of the process of manufacture of Portland cement. Ill. 4200 w. Pop Sci M—Dec., 1901. No. 44615 C.

Tests of American Slag Cements. William Kendrick Hatt. A statement of the nature and properties of slag cements and a report of the results of tests performed at Purdue University on five kinds of American cement made from blast furnace slag as one element in the product. 6000 w. Indiana Engng Soc—1901. No. 44416 D.

The Chemical and Physical Properties of Portland Cement. B. Brentnall Lathbury. Brief notes on the important ingredients, physical properties and tests. 1000 w. Br Build—Nov., 1901. No. 44,638 D.

The Determination of Alkalies in Portland and Natural Cements. Thomas B. Stillman. Explains the scheme for the anaylsis. 1400 w. Stevens Ind—Oct., 1901. No. 44079 D.

The Relative Merits of Portland and Natural Cements for Street Foundations. C. H. Rust. Discusses the advantages of Portland over natural cement. 800 w. Munic Engng—Nov., 1901. No. 44159 C.

Concrete.

The Use of Concrete. Victor K. Hendricks. Gives instructions and suggestions for obtaining good work. 9000 w. Indiana Engng Soc—1901. No. 44414 D.

Timber Preservation.

Methods of Injecting Timber (Du Controle de l'Injection et de la Reception des Bois Injectés). M. Vinsonneau. An examination of the various antiseptic solutions and methods used for the preservation of timber. 2000 w. Revue Technique—Oct. 10, 1901. No. 44550 D.

Wooden Columns.

The Computation of Wooden Columns Against Buckling (Berechnung der Hölzernen Säulen auf Knickfestigkeit). Max R. v. Thullie. With tables and curves computed from Tetmajer's formula. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 8, 1901. No. 44530 B.

MUNICIPAL.

Pavements.

Asphalt Pavements in the Borough of Manhattan, New York. Edward P. North. A review of the statistics of asphalt laid in 10 years under different requirements, pointing to a 15-year guaranty as the most economical term to require. 2400 w. Eng Rec—Nov. 2, 1901. No. 44144.

Pavement Guarantees. George W. Tillson. Considers the practice in detail, giving the writer's opinion of the proper requirements and the principals governing in each case. 4000 w. Munic Engng—Nov., 1901. No. 44158 C.

The Possibilities of the Use of Coal Tar in Bituminous Pavements. Fred J. Warren. Discusses points to be considered in selecting material, and the conditions on which the life of bituminous pavements depend. 2300 w. Munic Engng—Nov., 1901. No. 44157 C.

Sewage Disposal.

Sewage Disposal in Summer Resorts. Dr. P. H. Bryce. Simple, inexpensive, practical suggestions for places without sewerage systems. Ill. 2000 w. Can Archt—Oct., 1901. No. 44161 C.

New Sewage Screening Apparatus at Manchester. A description of works for removing detritus from the sewage before it passes through the disposal works. 1000 w. Eng Rec—Nov. 16, 1901. No. 44409.

Septic Tanks and Contact Beds at Plainfield, N. J. Andrew J. Gavett. An illustrated description of a new plant consisting of two septic tanks and a double set of bacterial contact beds. 1700 w. Eng Rec—Nov. 16, 1901. No. 44407.

WATER SUPPLY.

Ozone.

Water Purification by Means of Ozone. Brief illustrated description of an experimental plant erected in Berlin some three years ago. 900 w. Elec Engr, Lond—Nov. 8, 1901. No. 44330 A.

Protection.

Protection of Water Supplies. Gives abstracts of three papers and their discussion, as presented to the recent conference on Water Supply and Pollution, in England. Deals with the protection of watersheds, underground supplies, and the rights of underground pumping. 8500 w. Jour Gas Lgt—Oct. 29, 1901. No. 44284 A.

Rainfall.

Rainfall and Village Water Supplies. Abstracts of papers with the discussions thereon, presented to the Conference on Water Supplies and River Pollution. 9700 w. Jour Gas Lgt—Nov. 5, 1901. No. 44300 A.

Reservoirs.

The Failure of the East Liverpool Reservoir. Illustrated description of a concrete-lined reservoir bank 23 ft. deep, which failed where the drain pipe passed through it. 500 w. Eng Rec—Nov. 2, 1901. No. 44151.

Spillways.

Spillways and Drainage Areas. E. Sherman Gould. A discussion of Mr. Frizell's formula. 2200 w. Eng News —Nov. 14, 1901. No. 44389.

Tank Failure.

The Failure of the Elevated Water Tank at Fairhaven, Mass. An illustrated description of a tank having a curved bottom, with report of the failure and views of the wreck. 2800 w. Eng News—Nov. 21, 1901. No. 44476.

The Collapse of the Fairhaven Water Tower. Describes the tower and the accident. 1300 w. Eng Rec—Nov. 16, 1901. No. 44413.

Wells.

Experimental Well Boring (Versuchsbrunnenanlagen). H. Prinz. A discussion of the deductions to be made from borings to determine the nature of groundwater seams for water supply. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 9, 1901. No. 44524 D.

MISCELLANY.

Engineering Profession.

The Duty of the Engineer. A topical discussion. I. To Himself and His Profession. Edgar Marburg. II. To His Clients or Employers, John Birkinbine. III. To His Contractors and Employees, L. Y. Schermerhorn. IV. To the Public, John C. Trautwine, Jr., with general discussion. 1600 w. Pro Engrs' Club of Phila—Oct., 1901. No. 44430 D.

The Position of the Engineer in Municipal Service. Alex. Dow. Presidential address before the Detroit Engng. Soc. How to divorce public business from politics. 5800 w. Jour Assn of Engng Soc—Sept., 1901. No. 44112 C.

Exposition Buildings.

Coloring and Decorating the Pan-American Exposition. C. Y. Turner. Read before the Am. Inst. of Archts. Gives an account of the things needing to be considered in working out the color scheme and the need of early consultation of architect, sculptor, colorist and landscape architect. 4500 w. Am Archt—Nov. 16, 1901. No. 44345.

Forestry.

The Forester, an Engineer. B. E. Fernow. An illustrated article showing the many applications of engineering knowledge to the business of wood production. Also discussion. 7200 w. Jour W Soc of Engrs—Oct., 1901. No. 44153 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Australia.

The Telegraph and Telephone Services of Australia. Abstract of the report issued by the Committee of Electrical Experts, as given in the *Melbourne Argus*. 1600 w. Elec Rev, Lond—Oct. 25, 1901. No. 44128 A.

Cable Laying.

Cable Laying in the Philippines. Frederick Moore. An illustrated account of the work and some of the difficulties. 900 w. Sci Am—Nov. 23, 1901. No. 44466.

Cables.

The Philippine Cable and Attending Work. Illustrated description of the difficulties encountered in establishing telegraphic communication in these islands. 1600 w. Elec, N Y—Nov. 13, 1901. No. 44283.

Exchange.

The Automatic Telephone Exchange at Fall River, Mass. Illustrated detailed description of an exchange without a switchboard and without operators. 1800 w. Elec Rev, N Y—Nov. 16, 1901. No. 44,-361.

The New Bell Telephone Exchange, Cortlandt Street, New York City. An account of the change from the old to the new exchange, with an illustrated description of the new exchange which is operated on the common battery system. The method of operation is briefly explained. 1700 w. Elec Wld & Engr—Nov. 9, 1901. No. 44273.

Space Telegraphy.

Marine Wireless Telegraphy. Editorial on the agreement between the Marconi International Marine Communication Co. and Lloyds. 1800 w. Elect'n, Lond—Oct. 25, 1901. No. 44125 A.

Movable Wireless Telegraphy Apparatus. Brief description of recent experiments by Mr. Marconi. Huge cylinders are used as receivers in place of the high wire, the apparatus being carried by an automobile which makes a speed of 12 to 14 miles an hour. 400 w. Elec Rev, N Y—Nov. 2, 1901. No. 44165.

Syntonic Wireless Telegraphy. A. Frederick Collins. Reviews the various systems, discussing them in detail. Ill. 5300 w. Elec Wld & Engr—Nov. 9, 1901. No. 44274.

Wireless Telegraphic Installation in H. M. Ships. Illustrations showing the manner in which the instruments are set up, with descriptions. 1500 w. Elec Rev, Lond—Nov. 15, 1901. No. 44610 A.

Storage Batteries.

Storage Battery and Controlling Board. J. W. Ayden. Read at the Convention of the International Assn. of Munic. Elect'ns. On the advantages of storage batteries, especially discussing the lead battery as adapted to fire and police telegraph systems. 1800 w. Fire & Water—Nov. 23, 1901. No. 44482.

Telegraphy.

Telegraph Systems, Operating Speeds and Economies. Romyn Hitchcock. Discusses the present condition of the telegraph, the reasons why the service is slow and costly, and the directions to look for improvements. 3000 w. Elec Wld & Engr—Nov. 16, 1901. No. 44383.

Telephony.

Some Notes on Bell's Telephone. Fred Deland. Gives in detail the steps that led to the invention of Bell's telephone. 8700 w. Telephony—Oct., 1901. No. 44089.

DISTRIBUTION.

Boosters.

Improvised Boosters. Walter M. Hollis. Discusses the use of a booster and an additional feeder, the conditions under which a series booster operates, and describes the construction of a booster. 2000 w. Am Elect'n—Nov., 1901. No. 44236.

Multiple-Wire.

The Balancing and Feeding of a Multiple-Wire Network. O. Dewey. Considers that the best arrangement for a large cross-connected network would be to have most of the feeders two-wire ones, and have a few multiple-wire feeders, so as to enable the network to be split up into sections for localizing faults. 3000 w. Elec Engr, Lond—Nov. 1, 1901. No. 44297 A.

Power Distribution.

Electric Power Distribution in a United States Navy Yard. An illustrated discussion of the equipment of the Brooklyn Navy Yard and the results obtained. 1800 w. Elec Wld & Engr—Nov. 2, 1901. No. 44194.

The Rise of Electric Power Distribution. Alton D. Adams. An examination of motive power statistics showing the growth. Also editorial. 4000 w. Elec Wld & Engr—Nov. 2, 1901. No. 44195.

Regulation.

Regulating Devices for Series Alternating Current Circuits. J. Henry Hallberg. Read before the Ohio Elec. Lgt. Assn. A general illustrated description of regulating apparatus and enclosed arc lamps for series alternating-current circuits, and a practical description of the series alternating-current enclosed arc system, using the reaction coil and shunt-wound arc lamp. 3500 w. Elec Rev, N Y—Nov. 23, 1901. No. 44484.

Rotary Converter.

The Design and Action of the Rotary Converter. D. B. Rushmore. A discussion of the principles and construction of this important apparatus in the transmission and utilization of electric power. 3500 w. Engineering Magazine—Dec., 1901. No. 44578 B.

Three-Wire.

The Three-Wire System. John H. Ryan, Jr. An explanation of why three wires are used and a statement of some of the troubles encountered, and methods of runnng. Ill. 3500 w. Engr, U. S. A.—Nov. 15, 1901. No. 44343.

Wiring.

Interior Conduit Construction and the National Electrical Code. Edward Sullivan. Calls attention to points that should be observed in installing the conduit system of wiring. 2400 w. Elec Rev, N. Y—Nov. 16, 1901. No. 44362.

I. Wiring Rules. C. H. Wordingham. II., Coventry Wiring Regulations, Jos. A. Jeckell. III., Letter, T. P. Wilmshurst. Three communications on the subject of wiring. 4400 w. Elect'n, Lond—Nov. 8, 1901. No. 44331 A.

ELECTRO-CHEMISTRY.

Accumulators.

A Process for Increasing the Capacity of Accumulators. C. Heim. Abstract of a paper read at Dresden meeting of the Verband Deutscher Electrotechniker. Discusses the influence of increase of temperature. 17000 w. Electr'n, Lond—Nov. 1, 1901. No. 44296 A.

Note on a Regenerative Accumulator and Its Application for Using Exhaust Steam. M. A. Rateau. Read before the Glasgow Congress. Illustrates a new apparatus intended to allow the use of the exhaust steam from machines having intermittent action. 700 w. Elec Engr, Lond—Nov. 8, 1901. No. 44329 A.

Acker Process.

The Acker Process for the Electrolytic Production of Alkalies and Chlorine. John B. C. Kershaw. Illustrated description of the process which is in operation at Niagara Falls. 1500 w. Elect'n, Lond—Oct. 25, 1901. No. 44126 A.

Cells.

A New Form of Diaphragm Cell for the Electrolytic Production of Alkalies and Chlorine. John B. C. Kershaw. Reviews briefly the types of diaphragm cells in actual use, and describes the cell patented by Moore, Allen, Ridlon and Quincy. 1500 w. Elect'n, Lond—Nov. 15, 1901. No. 44613 A.

Phosphorus.

On the Effect of Temperature and of Moisture on the Emanation of Phosphorus, and on a Distinction in the Behavior of Nuclei and Ions. C. Barus. Gives experimental investigations made and conclusions reached. 6600 w. Am Jour of Sci—Nov., 1901. No. 44113 D.

ELECTRO-PHYSICS.

Coherence.

Electrical Coherence. S. Alfred Varley. An account of the researches of the writer. 2800 w. Elec Rev, Lond—Nov. 1, 1901. No. 44301 A.

Electrons.

The Development of the Electron Idea. W. Kaufmann. From the *Physikalische Zeitschrift*. Lecture delivered at Hamburg, with editorial. 5200 w. Elect'n, Lond—Nov. 8, 1901. No. 44332 A.

High Frequency.

Electrical Oscillation of High Frequency. Arthur V. Abbott. Outlines the behavior of the three fundamental attributes of every electrical circuit—resistance, inductance, and capacity—showing by illustrations how each acts and the results of their mutual relations. Ill. 7300 w. Jour W Soc of Engrs—Oct., 1901. No. 44152 D.

Induction.

The Law of Magnetic Induction (Das Gesetz der Magnetischen Induktion). E. Müllendorf. A mathematical study of the laws governing induction, with tables showing the close agreement of computed and experimental values. 4500 w. Elektrotech Zeitschr—Nov. 7, 1901. No. 44565 B.

Interrupter.

Some Experiments on the Wehnelt Interrupter. M. A. Codd. An account of experimental investigations into the working of the electrolytic interrupter. 1600 w. Elec Rev, Lond—Nov. 15, 1901. No. 44609 A.

Lightning.

Tesla's Artificial Lightning. Harris J. Ryan. Photograph of a shower of electrical discharges produced, with remarks. 700 w. Sibley Jour of Engng—Nov., 1901. No. 44429 C.

Radiography.

A New Method of Obtaining Stereoscopic Effects in the Fluoroscope. Eugene W. Caldwell. Describes and illustrates improved systems for X-ray work by which stereoscopic X-ray vision may be obtained. 2000 w. Elec Rev, N. Y.—Nov. 16, 1901. No. 44360.

GENERATING STATIONS.

Alternators.

The Design and Construction of Alternators (La Construction et l'Etablissement des Alternateurs). A translation of the paper of M. Lasche recently presented before the *Verein Deutscher Ingenieure*. Serial. Part I. 1500 w. Revue Technique—Oct. 10, 1901. No. 44548 D.

The Hutin & Leblanc Compound Alternator (L'Alternateur Compound Système Hutin & Leblanc). A full detailed description of the large alternator exhibited at the Paris exposition. 2500 w. Revue Technique—Oct. 25, 1901. No. 44509 D.

Business Building.

Lighting and Heating in the Graham Court, New York. Illustrated description of the mechanical plant, including water-tube boilers, direct-connected electric units, electric elevators with a storage battery, and a special annunciator service, in an 8-story 170x200 ft. apartment house. 3500 w. Eng Rec—Nov. 2, 1901. No. 44149.

The Steam and Electrical Plant of the North American Building, Philadalphia. Description with plans of the plant for a twenty-one story office building. 6500 w. Eng Rec—Nov. 23, 1901. No. 44491.

Central Stations.

A Modern Small Central Station. W. H. Zimmerman. The plant of the Urbana (Ill.) Light, Heat and Power Company is illustrated and described. 1500 w. Am Elect'n—Oct., 1901. No. 44316.

Bringing Up to Date an Old-Style Central Station. Illustrates and describes the remodeled plant of the Georgia Electric Light Company. 3000 w. Am Elect'n—Oct., 1901. No. 44312.

Coal Handling.

Coal Handling Machinery in Central Stations. F. L. Hutchinson. Illustrated discriptions of arrangements used. 3200 w. Am Elect'n—Oct., 1901. No. 44318.

Dynamos.

Principles of Dynamo Construction. Presents principles essential to the design and construction of dynamos and motors, discussing each in detail. Ill. 3000 w. Elec, N. Y—.Nov. 13, 1901. Serial. 1st part. No. 44282.

The Design of a 5-K. W. Dynamo. An illustrated detailed description of a design to be constructed with the ordinary tools and appliances found in any engineering workshop. 5000 w. Elec Engr, Lond—Nov. 15, 1901. No. 44612 A.

Generating Sets.

Final Report of Committee on Standardization of Engines and Dynamos. 2600 w. Trans Am Soc of Mech Engrs, No. 887—Dec., 1901. No. 44625.

Generators and Transformers for the Bay Counties Power Co., California. E. Heitmann and Wm. Currie. Illustrated description of the generating units and the step-up transformers, discussing the principal features to be considered in making the selection. 2500 w. Eng News—Nov. 21, 1901. No. 44475.

Should Dynamos Be Used as Fly Wheels? (Sollen Dynamos als Schwungräder Dienen?). A. Rothert. A review of the conditions under which the revolving portion of a generator may properly be used as a fly-wheel for the engine. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 26, 1901. No. 44515 D.

Hydro-Electric Plant.

The Saut Mortier Power Station on the River Ain. Notes from a description by J. Claudet in *Le Genie Civil.* Ill. 1700 w. Eng Rec—Nov. 16, 1901. No. 44406.

Parallel Running.

Parallel Operation of Engine-Driven Alternators. W. L. R. Emmet. Read at meeting of the Am. Inst. of Elec Engrs. Presents a method of overcoming the difficulties of such operation which has been in successful use for three years in many important installations. 2500 w. St Ry Jour—Nov. 2 1901. No. 44203 D.

Parallel Running of Alternators. Ernest J. Berg. Considers the principles governing the parallel operation of alternators driven by steam engines or turbines. 1200 w. Trans Am Inst of Elec Engrs—Oct., 1901. No. 44427 D.

The Design of Engines for Operating Alternators in Parallel. R. H. Rice. Read at the meeting of the Am. Inst. of Elec. Engrs. Discusses the determining of the proper fly-wheel effect, and the type of governor. 1000 w. St Ry Jour—Nov. 2, 1901. No. 44204 D.

The Parallel Running of Alternators (Parallelbetrieb in Wechselstromsystemen). H. S. Meyer. A mathematical examination of the principles of parallel running, with an exposition of its advantages. 3500 w. Elektrotech Zeitschr—Oct. 31, 1901. No. 44562 B.

Polyphase.

The Computation of Polyphase Generators (Zur Berechnung Mehrphasiger Generatoren). K. Pichelmayer. With a table of co-efficients and diagram of characteristic curves for use in designing. 1800 w. Elektrotech Zeitschr—Oct. 31, 1901. No. 44563 B.

Power Plant.

The New Plant of the Virginia Electrical Railway & Development Co., Richmond, Va. Illustrated description of a plant in which the generating units are direct connected both to the turbine shafts of a hydraulic plant and the main shafts of a plant with vertical steam engines. The character of the water power, the nature of the service and the structural features are explained. 4400 w. Eng Rec—Nov. 9, 1901. No. 44208.

The Steam and Electric Plant of a Graphite Factory. Illustrates and describes the plant of the Joseph Dixon Crucible Company. 1700 w. Am Elect'n—Nov., 1901. No. 44233.

Speed Regulation.

See Mechanical Engineering, Steam Engineering.

Transformer.

General Electric Company's Constant Current Transformer for Alternating Series Arc Lighting. Report on the invention of Prof. Elihu Thomson. Ill. 1700 w. Jour Fr Inst—Nov., 1901. No. 44,-225 D.

Some Up-to-Date Transformers. W. E. Warrilow. Illustrates and describes recent designs showing the advances made. 3000 w. Elec Engr, Lond—Oct. 25, 1901. Serial. 1st part. No. 44124 A.

Transformers. A. S. M'Allister. Concerning the behavior of the transformer built according to modern practice. 3500 w. Am Elect'n—Oct., 1901. No. 44313.

LIGHTING.

Accounting.

Modern Electric Light Accounting. A S. Knight. Abstract of a paper read at the Buffalo meeting of the Assn. of Edison Ill. Co.'s, describing the accounting system of the Boston Edison Company. 3300 w. Elec Wld & Engr—Nov. 2, 1901. No. 44197.

Arc Lights.

Relative Merits of Open and Enclosed Arc Lights for Street Illumination. W. D'A. Ryan. Abstract of a paper read before the Ohio Elec. Lgt. Assn. Considers the peculiarities of different lamps, small vs. large units, etc. giving candle-power curves and curves showing street illumination. 1600 w. Am Elect'n—Nov., 1901. No. 44235.

Narragansett System.

The Narragansett Electric Lighting Company's System. An illustrated description of the installation that furnishes light and motive power for half the State of Rhode Island. 3800 w. Elec Rev, N. Y—Nov. 9, 1901. No. 44249.

Street Lighting.

Electric Street Lighting and Population. Alton D. Adams. An examination of the relation existing between the extent of population and the use of electric street lamps in the State of Massachusetts, the kinds of lamps used, etc. 2000 w. Elec Rev, N. Y.—Nov. 9, 1901. No. 44251.

United States.

The Electric Lighting Industry of the United States. A tabular statement of the present status of this industry, giving facts and figures hitherto unpublished. Also editorial. 2000 w. Elec Rev, N. Y—Nov. 9, 1901. No. 44250.

MEASUREMENT.

Compensation.

A New Form of the Thiermann Compensator (Eine Neue Form des Thiermannschen Kompensators). P. Heyck. Describing an improved form of the Thiermann device for measuring currents by compensation. 2500 w. Elektrotech Zeitschr—Oct. 17, 1901. No. 44560 B.

Electric Meters.

Some Fundamentals of Electric Meters. Caryl D. Haskins. Discusses the relation between torque, friction, aging of various kinds, and local surroundings as affecting inter-accuracy. 2000 w. Trans Am Inst of Elec Engrs—Oct., 1901. No. 44422 D.

Electroscope.

A Method of Determining Very Small Electrical Charges (Sur une Methode Propre à Déceler de Très Petites Charges Electriques). R. Blondlot. A communication to the French Academy describing a very sensitive form of electroscope. 1200 w. Comptes Rendus—Nov. 4, 1901. No. 44547 D.

Energy Meters.

Metering of Electrical Energy. Harry P. Davis. Notes outlining some of the more important features which should be embodied in the ideal meter, with data and a brief description of a test on a meter largely used. 3500 w. Trans Am Inst of Elec Engrs—Oct., 1901. No. 44423 D.

Indicator.

The Construction of a Current and Potential Indicator. Sketches, with explanations, illustrating the essential features of a simple indicator which may be wound either to serve as a voltmeter or potential indicator, or as an ammeter or current indicator. 1200 w. Am Elect'n—Oct., 1901. No. 44319.

Lag.

Measurement of the Angle of Lag of Three-Phase Circuits with One Wattmeter. A. S. McAllister. Outlines the method. 700 w. Elec Wld & Engr—Nov. 23, 1901. No. 44627.

Power Factor.

A Means of Measurement of the Angle of Lag and the Power Factor with a Voltmeter. George T. Hanchett. Gives an interesting method of measuring the power factor of an alternating-current circuit, requiring no other instrument than the voltmeter. 800 w. Elec Wld & Engr—Nov. 2, 1901. No. 44196.

POWER APPLICATIONS.

Cranes.

Electric Traveling Crane for a Steel Foundry (Elektrisch Betriebener Laufkran für eine Stahlwerk-Giesshalle). A. Kolben. With details of the hoisting gear and scheme of the wiring for a 10-ton crane of 11 metres span. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 26, 1901. No. 44514 D.

Recent Electric Cranes (Neuere Elektrisch Betriebene Hebezeuge). Illustrated description of 100-ton electric wharf crane at Bremen. 1500 w. 1 plate. Zeitschr d Ver Deutscher Ing—No. 44,-518 D.

20-Ton Locomotive Steam Crane. Illustration with brief description of a powerful tool built in England for use in Mexico. 500 w. Engng—Nov. 8, 1901. No. 44340 A.

Electrical Industries.

Electricity in the Service of Man. A. N. Brady. Briefly reviews the many applications of electricity, and the large investments represented. 2400 w. N Am Rev—Nov., 1901. No. 44118 D.

Electrogravure.

An Electro-Mechanico-Chemical System of Die Sinking and Engraving. Describes a process for automatically cutting away steel surfaces in irregular and delicate shapes. Ill. 1400 w. Am Mach—Nov. 7, 1901. No. 44265.

Lathe Driving.

Electrically Driven Lathes (Tours Actionnés Electriquement). Ch. Dantin. Showing the application of electric driving to large lathes for turning crank shafts of marine engines. 1500 w. Génie Civil —Oct. 19, 1901. No. 44506 D.

Mining Plant.

The Application of Electric Power to Mining (Anwendungen der Elektrizität im Bergbau). R. Goetze. A general examination of the adaptation of electric power to mining, including pumping and hoisting. 5000 w. Glückauf—Oct. 19, 1901. No. 44551 B.

Oil Wells.

Electrical Engineering at Oil Wells. On the use of electrical facilities in connection with blasting. Ill. 1300 w. Min Rept—Nov. 14, 1901. No. 44401.

Power Plant.

Power Plant of the Rose Building, Cleveland. Illustrated detailed description of plant. All the machinery in the building is steam driven except the elevators. 4200 w. Engr, U S A—Nov. 1, 1901. No. 44168.

Railway Motors.

The Determination of the Capacity of Railway Motors (Die Berechnung der Motorleistung im Bahnbetrieb). M. Müller. Showing the limitations as to sparking and overheating of motors at maximum load, with methods of computing these limits. 4000 w. Elektrotech Zeitschr —Nov. 7, 1901. No. 44564 B.

Rock Drill.

Electric Solenoid Impact Rock Drill (Elektrische Solenoid-Stossbohrer für Härtes Gestein). E. Heubach. A review of early electrical rock drills and a description of the improved drill of the Union Elektricitäts Gesellschaft and its work in hard rock. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 19, 26, 1901. No. 44512 each D.

Rubber Works.

The Power Plant of the Silvertown India-Rubber Works. An illustrated description of the latest extensions to the plant. The installation is as large as is often provided for a town of 50,000 inhabitants, and is interesting because of the diversity of uses to which the motors are put. 1400 w. Elec Rev, Lond—Nov. 15, 1901. No. 44611 A.

Shipbuilding Plant.

The Electrical Equipment of Messrs. Palmer's Shipbuilding Works. Illustrates and describes the recent electrical equipment of the shipbuilding and engine departments of these extensive works at Jarrow-on-Tyne. 5000 w. Engng—Nov. 1, 1901. No. 44305 A.

Silk Mill.

Power Plant of a Large Silk Mill. Illustrated description of the plant in a mill at Altoona, Pa. 3200 w. Engr, U S A—Nov. 15, 1901. No. 44342.

TRANSMISSION.

Conductors.

The Arrangement of Overhead Conductors (L'Etablissement des Canalisations Aériennes). A discussion upon the stresses and deflections for long spans. 7000 w. Bull Soc Int des Elec—Aug., Sept., Oct., 1901. No. 44545 G.

Controlling.

Efficiency of Multiple Voltage Control in Electric Power Transmission. Lehman B. Hoit. Calls attention to the several ways in which losses occur in the use of power electrically transmitted. Brief discussion. 4500 w. Jour Assn of Engng Socs—Sept., 1901. No. 44111 C.

Electrical Surges.

Surges in Transmission Circuits. A. E. Kennelly. Considers electrical oscillations in circuits containing inductance and capacity. 4500 w. Elec Wld & Engr—Nov. 23, 1901. No. 44626.

High Potential.

Theoretical Investigations of Some Oscillations of Extremely High Potential in Alternating High Potential Transmissions. Charles Proteus Steinmetz. Gives a series of investigations on the effect of the exponential term in the general equation of alternating currents. 4200 w. Trans Am Inst of Elec Engrs. Oct., 1901. No. 44424 D.

Long Span.

Some Further Details of the Carquinez Span. Illustrates and describes details relating to the mechanical features of the towers. 1200 w. Jour of Elec—Oct., 1901. No. 44359.

Output.

Electrical Incomes and Outputs per Ton of Coal. Alton D. Adams. Presents figures derived from the report of the Gas and Electric Light Commissioners of Massachusetts, considering information gained from the study. 2200 w. Elec Wld & Engr—Nov. 16, 1901. No. 44382.

Snoqualmie.

Aesthetics in, and Extensions of the Snoqualmie Transmission. Gives an illustrated description of the tower over the shaft crowning the elevator entrance to the subterranean works, and the new substations in Seattle and Tacoma. Also describes the extension to be carried out. 3400 w. Jour of Elec—Oct., 1901. No. 44358.

MISCELLANY.

Address.

Inaugural Address by C. H. Wordingham before the Manchester Section of the Institution of Electrical Engineers. Describes technical questions of interest to the practical engineer in relation to electrical engineering. 4000 w. Elec Engr, Lond—Nov. 22, 1901. Serial. 1st part. No. 44723 A.

Mr. W. E. Langdon's Presidential Address to the Institution of Electrical Engineers. A review of electrical achievements from the standpoint of a railway engineer, and a discussion of the future prospects. 5000 w. Elect'n, Lond—Nov. 22, 1901. Serial. 1st part. No. 44718 A.

Electrical Engineering.

The Debt of Electrical Engineering to C. E. L. Brown. B. A. Behrend. The first of several articles giving an account of the work of a great engineer, and also showing the origin of many of the standard types of electrical apparatus. 3000 w. Elec Wld & Engr—Nov. 16, 1901. Serial. 1st part. No. 44380.

Modern Theories.

Outline of Modern Theories of Electricity and Magnetism. Harold B. Smith. Briefly outlines the theories and hypotheses and recent discoveries in electrical phenomena. 4000 w. Jour Worcester Poly Inst—Nov., 1901. No. 44119 C.

Report.

Report of the Commission of the Société Internationale des Electriciens to the Convention of the American Institute of Electrical Engineers (Rapport sur la Mission Envoyé par la Société Internationale des Electriciens au Congrés de l' American Institute of Electrical Engineers). 20,000 w. Bull Soc Int des Elec—Aug., Sept., Oct., 1901. No. 44544 G.

GAS WORKS ENGINEERING

Acetylene.

Acetylene Gas. Harry C. Earle. On the progress as an illuminant, the claims made, the principle of the generators, &c. 1400 w. Sibley Jour of Engng—Nov, 1901. No. 44428 C.

Acetylene Gas in Germany and Sweden. Reports on the uses of acetylene in the countries named. 1200 w. U S Cons Repts—Oct. 31, 1901. No. 44072 D.

Calorimetry.

On the Determination of the Heat of Dissociation and of Combustion of Acetylene, Ethylene, and Methane. W. G. Mixter. An account of experimental investigations made at the Sheffield Laboratory of Yale University. 3000 w. Am Jour of Sci—Nov., 1901. No. 44114 D.

Coal Gas.

Mr. W. Foulis on the Economical Production and Utilization of Coal Gas. From the inaugural address before the Inst. of Engrs. & Shipbuilders of Scotland. Considers the question of the economical production of gas from coal, and its utilization. 6000 w. Jour Gas Lgt—Nov. 5, 1901. No. 44299 A.

Coke-Oven Gas.

The Production of Illuminating Gas from Coke-Ovens. The reply of Dr. F. Schniewind to the discussion on his paper at the Glasgow Gas Congress. 3300 w. Jour Gas Lgt—Nov. 12, 1901. No. 44601 A.

Extensions.

Extensions at the Nechells and Saltley Gas Works, Birmingham, Eng. Henry Hack. Illustrated notes describing the extensions made since 1898. 8500 w. Gas Wld—Oct. 26, 1901. No. 44129 A.

Gasholders.

An Intze Gasholder Tank. Extract from the specifications for an improved gasholder, by Otto Intze. Describes a new construction of annular metal gasholder tank, giving drawings. 1500 w. Gas Wld—Nov. 9, 1901. No. 44328 A.

Intze Gasholders and Tanks. An abstract of the patent specification, with illustrations. 2000 w. Jour Gas Lgt—Nov. 12, 1901. No. 44602 A.

High Pressure.

Notes on High Pressure Gas Lighting. A. W. Onslow. Referring to means of securing a large amount of light from one burner. Discussion. 4200 w. Gas Wld—Nov. 16, 1901. No. 44608 A.

Light Distribution.

The Distribution of Gas Light in Space and the Technical Application of Milk-Glass. Dr. O. Schott and Dr. M. Herschkowitsch. Summary from the *Journal für Gasbeleuchtung.* Gives curves showing how the light is distributed, and discusses the effect of diffusing glass. 1000 w. Gas Wld—Nov. 9, 1901. No. 44327 A.

Management.

What Is the Business of a Gas Company? Frank D. Moses. Read at meeting of the Am. Gas Lgt. Assn. Considers ways to increase the sale of gas. Also discussion. 4500 w. Pro Age—Nov. 15, 1901. No. 44344.

Modern Practice.

Modern Practice in the Manufacture and Distribution of Gas. Harry Edward Jones. Begins the publication of an interesting paper presented to the Inst. of Civ. Engs., with a report of the discussion upon it. 4000 w. Gas Wld—Nov. 9, 1901. Serial. 1st part. No. 44326 A.

Naphthalene.

Further Experiences with Reversible Condensers. Charles Carpenter. Read before the So. Dist. Assn. of Gas Engrs & Mgrs. Explains the writer's successful method of abolishing the naphthalene trouble. Ill. 2000 w. Gas Wld—Nov. 16, 1901. . No. 44606 A.

Natural Gas.

Natural Gas Production. F. H. Oliphant. Reviews the gas-producing areas of the United States, giving information related. 4500 w. Am Mfr—Nov. 7, 1901. No. 44223.

Power Gas.

See Mechanical Engineering. Power and Transmission.

Prepayment Meters.

Some Considerations Respecting the Slot Metre System and the Suggestion of a Hire-Purchase System for Fittings, &c., as an alternative. George Helps. Discusses what should be expected of the slot system, the objections, an alternative system and its advantages. 5500 w. Gas Wld—Nov. 2, 1901. No. 44294 A.

Residuals.

The Fuel Value of Residuals. Charles F. Prichard. Read before the Am. Gas Lgt. Assn. Gives ultimate analyses of residuals which have fuel values, their fuel values based on these analyses, their fuel values tested by calorimeter, and their fuel value obtained by burning large quantities of them and the methods employed. 3700 w. Am Gas Lgt Jour—Nov. 18, 1901. No. 44402.

Retort Ovens.

Retort Ovens as Producers of Illuminating Gas. T. Littlehales. Read at meeting of the Am. Gas. Lgt. Assn. An extended discussion of this subject concluding that in gas works of even moderate size, operating with retort ovens, and turning out first-class foundry coke, good profits can be made with gas at prices impossible for retort methods to compete with. Ill. 7500 w. Am Gas Lgt Jour—Nov. 11, 1901. No. 44269.

Retort Ovens as Producers of Illuminating Gas. Discussion of Mr. Thomas Littlehale's paper. 2000 w. Am Gas Lgt Jour—Nov. 25, 1901. No. 44628.

Retorts.

The Construction and Method of Charging Inclined Retorts. Gilbert Little. Relating to improvements for reducing cost and improving quality of machinery. Ill. 1700 w. Jour Gas Lgt—Oct. 22, 1901. No. 44105 A.

The Economical Advantages of Inclined Retort-Settings. W. R. Herring. A discussion of this subject, referring to a former paper, and to the views of others, and considering the automatic discharging of inclined retorts. 2800 w. Jour Gas Lgt —Nov. 5, 1901. No. 44298 A.

Special Work.

Experiences Encountered During the Alterations to Connections of an 80-Foot Diameter Water Gas Relief Holder and Tank. T. Randolph Murray. Read before the So. Dist. Assn. of Gas Engrs. & Mgrs. An account of a somewhat difficult piece of work. A gasholder tank was emptied while the holder was kept in work almost up to the last moment. 6000 w. Gas Wld—Nov. 16, 1901. No. 44607 A.

Standards.

A Comparison of Standards for Cast Iron Pipe and Specials. Walton Forstall. Read before the Am. Gas Lgt. Assn. Discusses the differences between the standards of the Association and those now in use by the United States Gas Improvement Company. 3500 w. Am Gas Lgt Jour—Nov. 25, 1901. No. 44629.

Vienna.

The Vienna Municipal Gas-Works. An illustrated description prepared mainly from a brochure issued at the meeting of the gas and water engineers last June. 2600 w. Jour Gas Lgt—Nov. 12, 1901. Serial. 1st part. No. 44600 A.

Water Gas.

Early Plant for Making Water Gas. An illustrated account of an apparatus constructed in France in 1819, by Philippe Gengembre and his son, Antoine. 1200 w. Jour Gas Lgt—Nov. 12, 1901. No. 44603A.

Tar and Water from Water Gas. W. E. McKay. Read before the Am. Gas Assn. Tabulated data showing the changes in the manufacture of gas and in the sales of residuals, in Massachusetts, during the past 14 years, with description of system of separation used, and other information. 11700 w. Am Gas Lgt Jour—Nov. 4, 1901. No. 44106.

INDUSTRIAL ECONOMICS

Coal Exports.

The Growth of American Coal Exports. F. E. Saward. A study of the increasing exports of American coal, showing how this cheap source of fuel supply will promote European industries. 3500 w. Engineering Magazine—Dec. 1901. No. 44-571 B.

Competition.

The Manufacturers' View. Discusses some of the principal reasons for the loss of British trade, from the standpoint of the manufacturer of structural materials. 9300 w. Engr, Lond—Nov. 8, 1901. Serial. 1st part. No. 44335 A.

Cost Keeping.

The Proper Distribution of the Factory Expense Burden. A. Hamilton Church. In his sixth, and closing paper, Mr. Church discusses the proper apportionment of office and selling expense, and also makes a summary of the whole series of articles. 4000 w. Engineering Magazine—Dec., 1901. No. 44574 B.

Germany.

Commerce and Industries of Germany in 1900. A full discussion of conditions in Germany, the imports and exports, the various industries, American competition, tariff revision, &c. 5700 w. U S Cons Repts, No. 1185—Nov. 9, 1901. No. 44192 D.

Improvements.

Economics of Railway Improvements. W. W. Colpitts. From a paper read before the Canadian Soc. of Civ. Engrs. Discusses mistakes made in railway engineering, and the various improvements that make for economy of operation. 4700 w. Ry & Engng Rev—Nov. 23, 1901. Serial. 1st part. No. 44631.

Trade-Unionism.

Trade Unionism in Coal-Mining. The first of a series of articles discussing the recent growth of the system in Great Britain. 2000 w. Ir & Coal Trds Rev—Nov. 22, 1901. Serial. 1st part. No. 44-735 A.

MARINE AND NAVAL ENGINEERING

Armor.

Recent Experiments in Attacking Armor with High Explosive Shell. E. B. Babbitt. An account of the investigations of the Board of Ordnance and Fortification, the tests made and results. 4000 w. Soc Nav Archts & Marine Engrs, No. 10—Nov., 1901. No. 44440 C.

Balancing.

The Theoretical and Practical Methods of Balancing Marine Engines. D. W. Taylor. Description and demonstration of methods for the determination of unbalanced forces and moments of unbalanced couples in a known engine, and of balancing engines so as to reduce or extinguish unbalanced forces. Ill. 17000 w. Soc Nav Archts & Marine Engrs—Nov., 1901. No. 44438 D.

The Theoretical and Practical Methods of Balancing Marine Engines. Rear Admiral George W. Melville. A discussion of the various methods proposed or actually tried, giving their merits and demerits, and especially describing the MacAlpine system, which the writer believes to be the best. Ill. 15000 w. Soc Nav Archts & Marine Engrs—Nov., 1901. No. 44436 D.

Battleships.

A Brief Comparison of Recent Battleship Design. H. G. Gillmor. Compares the most recent designs of the several principal naval powers, in regard to armament, protection, speed, and coal supply. 3800 w. Soc Nav Archts & Marine Engrs, No. 7—Nov., 1901. No. 44437 C.

French First-Class Battleship "Charlemagne." Illustration and description of this French battleship and the novel method of mounting the main battery. 1100 w. Sci Am—Nov. 16, 1901. No. 44366.

Cobra.

The Cobra Disaster. Reviews the circumstances of the disaster and the judgment of the court-martial. 3500 w. Engr, Lond—Oct. 25, 1901. No. 44135 A.

Cruiser.

H. M. Armored Cruiser "King Alfred." Illustrated description of one of four vessels building for the British navy, and its equipment. 1200 w. Engng—Nov. 1, 1901. No. 44306 A.

The French Cruiser Jurien de la Gravière. Illustration, and a comparison with the British vessel "Hyacinth." 1000 w. Engr, Lond—Nov. 15, 1901. No. 44621 A.

Ferryboat.

New Steel Ferryboat. Illustration, with description of the Cape May, the latest addition to the fleet on the Delaware. 2000 w. Naut Gaz—Nov. 2, 1901. No. 44470.

Gunnery.

Naval Gunnery. S. Eardley-Wilmot. Discusses the lack of attention in the British Navy, to securing gun efficiency and the importance of drill and constant training. 2000 w. Engr, Lond—Nov. 1, 1901. No. 44308 A.

Inspection.

The United States Inspection Service. James A. Dumont. Gives a comparative statement of the work of the service for the year 1871 and 1900 inclusive, discussing the sinking of the Staten Island ferryboat Northfield, and other matters. 3800 w. Naut Gaz—Oct. 31, 1901. No. 44091.

Launching.

Side Launch of Torpedo-Boats and Torpedo-Boat Destroyers. W. G. Groesbeck. Describes the launching of torpedo-boats Shubrick, Stockton and Thornton, and of torpedo-boat destroyers Dale and Decatur launched sideways because of the limited extent of land and water available. Ill. 2500 w. Soc Nav Archts & Marine Engrs, No. 12—Nov., 1901. No. 44442 C.

Launch Motor.

Design for a 3 H. P. Launch Motor. Cecil P. Poole. Sketches showing the important features of a multipolar motor designed for driving the screw propeller of a pleasure boat, with description. 1500 w. Am Elect'n—Nov., 1901. No. 44238.

Merchant Marine.

Restoration of the American Merchant Marine. Richard P. Joy. Reviews the early history and the present position, and urges the taking of such measures as will restore the country's flag to its former glory on the seas. 2500 w. Marine Rev—Nov. 14, 1901. No. 44357.

Naval Warfare.

Naval Fashions. Archibald S. Hurd. Discusses the experiments in the construction of war vessels. 4900 w. Nineteenth Cent—Nov., 1901. No. 44321 D.

Navy Yard.

The Puget Sound Navy Yard. A. B. Wyckoff. An illustrated article explaining the natural advantages and the present development. 1400 w. Sci Am—Nov. 23, 1901. No. 44468.

Ordnance.

Late Developments in Ordnance and Armor. J. F. Meigs. Reviews the advances made during the last ten years.

6000 w. Soc Nav Archts & Marine Engrs, No. 9—Nov., 1901. No. 44439 C.

Important competitive Test of High Explosive Shells at Sandy Hook. Illustrated description of very important trials with discussion of the results. Also editorial. 3000 w. Sci Am—Nov. 30, 1901. No. 44649.

Organization.

Organization of the Engineer Division on Board a Man-of-War. C. W. Dyson. Gives the writer's ideas as to the proper organization. Also general discussion. 8000 w. Jour Am Soc of Nav Engrs—Nov., 1901. No. 44640 H.

Police Launch.

Design of German Police Launch Built at Howaldtswerke, Kiel, Germany. George Crouse Cook. An illustrated description of a high-powered steam launch. 1200 w. Marine Engng—Nov., 1901. No. 44259 C.

Propeller Shaft.

Installing a Propeller Shaft Without Docking. H. Webster. Illustrated account of the method used in the torpedo-boat "Shubrick." The stern of the vessel was raised and the work carried on from floats. 800 w. Marine Engng—Nov., 1901. No. 44261 C.

Propellers.

Propeller Design. Theodore Lucas. An illustrated discussion of the important factors. 1400 w. Naut Gaz—Nov. 7, 1901. No. 44252.

Salvage.

A Novel Salvage Operation. Waldon Fawcett. Illustrates and describes the raising of the Columbia River lightship from the sands on the beach on the N. Pacific Coast, and the removal of the vessel overland to the waters of Baker's Bay. 1600 w. Sci Am—Nov. 16, 1901. No. 44364.

Shaft Breakages.

Causes of Breakage of Propeller Shafts. Discusses the causes of failure under poor material, unforeseen straining and corrosion. Ill. 2300 w. Marine Engng—Nov., 1901. No. 44257 C.

Shipbuilding.

The New Machine Shop and Power House at the Cramp Shipyard. An illustrated description of the recent improvements made which nearly doubles the capacity of this plant. 800 w. Naut Gaz—Nov. 7, 1901. No. 44253.

Shipping.

The End of Prosperity for the Ship Owner. Editorial discussion of the changes during recent years and the present situation. 1300 w. Eng News—Nov. 7, 1901. No. 44278.

Speed Trial.

Trial of Speed Between the Steamers City of Erie and Tashmoo. Frank E. Kirby. Illustrations with descriptions of steamers and an account of the trial on Lake Erie on June 4, 1901. 1300 w. Soc Nav Archts & Marine Engrs, No. 1—Nov., 1901. No. 44433 C.

Steamer.

Passenger Steamer Puritan. Illustrated detailed description of a steamer for the Great Lakes to ply between Holland, Mich., and Chicago. 1300 w. Marine Engng—Nov., 1901. No. 44258 C.

Steamship Construction.

A Graphical Record of Progress in Steamship Construction. Chart prepared by Herr Otto Schlick showing typical steam vessels from the beginning of steam navigation to the present time all drawn to the same scale. Brief descriptions are given. 1000 w. Eng News—Nov. 14, 1901. No. 44391.

Steamship.

Express Steamship Kronprinz Wilhelm. Brief illustrated description of this new liner for the North German Lloyd Co. 1500 w. Marine Engng—Nov., 1901. No. 44256 C.

Fine Coasting Steamship. Illustration, with brief description of the Denver, a fine vessel of the Mallory line. 1000 w. Naut Gaz—Oct. 31, 1901. No. 44090.

Stresses.

The Effect of Variation of Dimensions upon the Stresses in a Ship's Structure. Herbert C. Sadler. Discusses this subject, considering the forces which tend to strain the vessel as a whole, and those which tend to strain it locally. Plates. 4400 w. Soc Nav Archts & Marine Engrs, No. 2—Nov., 1901. No. 44434 C.

Tidal Corrections.

Some Notes on Tidal Corrections. Edwin A. Stevens. Tidal calculations made on progressive trial runs, with methods used. 1500 w. Soc Nav Archts & Marine Engrs, No. 11—Nov., 1901. No. 44441 C.

Torpedoes.

Power Consumed in Propelling the Whitehead Torpedo at Various Speeds. Frank M. Leavitt. An account of tests made to ascertain the efficiency of the motive power, and the amount of power required to drive the torpedo at various speeds up to thirty-three knots per hour. Ill. 4400 w. Soc Nav Archts & Marine Engrs, No. 4—Nov., 1901. No. 44435 C.

Wastage.

Wastage of the Navies. A long list of disasters showing that storms do much more damage than wars. 1800. Marine Rev—Nov. 7, 1901. No. 44227.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol Motors.

Alcohol Motor Car Trials in France. Concerning the trials being carried out by the Minister of Agriculture to open a source of consumption for alcohol. Ill. 3200 w. Engr, Lond—Nov. 8, 1901. No. 44336 A.

The French Alcohol Carriage Trials. Brief account of trials in the neighborhood of Paris for obtaining official data upon the economy of alcohol, and its utilization. Ill. 1500 w. Autocar—Nov. 9, 1901 No. 44325 A.

Bakery Vehicle.

A Military Bakery Automobile. An illustrated description of a flour mill and bakery automobile designed to follow regiments and make fresh bread every hour from wheat obtained by requisition. 500 w. Sci Am Sup—Nov. 16, 1901. No. 44371.

Boiler Test.

Test of Capacity and Economy of Boiler of a Motor Carriage. Charles D. Chasteney. Abstract from graduation thesis describing a test made to determine the horse-power and general performance of the boiler. 1400 w. Stevens Ind—Oct., 1901. No. 44081 D.

British Car.

A New British Autocar. Illustrated description of a new design. 800 w. Autocar—Nov. 16, 1901. No. 44604 A.

Diagram.

Diagram for Motor Vehicle Problems. P. S. Bushnell. Chart for quickly solving calculations arising in motor vehicle design, with explanation. 500 w. Am Mach—Nov. 14, 1901. No. 44352.

Graphical Representation of the Cycles of Petroleum Motors (Représentation Graphique du Cycle des Moteurs à Pétrole). L. Nerdeux. Showing the application of the Zeuner diagram to internal combustion motors. 1500 w. Revue de Mécanique—Oct. 31, 1901. No. 44535 E + F.

Duryea Vehicles.

A Chapter of History and an Interesting Car. An account of the struggle for success with an illustrated description of vehicles. 2000 w. Autocar—Nov. 16, 1901. No. 44605 A.

Electric Vehicles.

Some Electric Vehicles at the Show. P. M. Heldt. Comments on the exhibits at the recent Automobile show at Madison Sq. Garden, N. Y. 900 w. Horseless Age—Nov. 6, 1901. No. 44248.

Exhibition.

Some Exhibits at the Automobile Show. Illustrations and descriptions of vehicles at the second annual Automobile show at Madison Sq. Garden, N. Y. 1500 w. Sci Am—Nov. 16, 1901. No. 44370.

The Automobile Show. An illustrated account of the recent annual exhibition held at Madison Square Garden, New York. 2700 w. Auto Mag—Dec., 1901. No. 44632 C.

Experience.

Commonplace Automobile Experience. An account of troubles of various sorts, and some of the causes. 2200 w. Horseless Age—Nov. 6, 1901. No. 44245.

Practical Automobile Experience. Dr. Charles H. Lemar. Gives facts from a physician's experience, not very encouraging for doctors of moderate incomes. 1200 w. Horseless Age—Nov. 6, 1901. No. 44244.

Some Automobile Experience by a Country Physician. Willets P. Haines. Gives experience with gasoline and steam vehicles. 2000 w. Horseless Age—Nov. 6, 1901. No. 44243.

Two Years' Experience with Two Gasoline Wagons. Dr. George P. Jesup. An account of things learned, cost, &c. Considers the automobile an ideal but rather expensive conveyance. 1500 w. Horseless Age—Nov. 6, 1901. No. 44242.

Fire Engines.

Modern German Fire Engines. Illustrated description of motor fire-engines of various types. 700 w. Sci Am Sup—Nov. 16, 1901. No. 44372.

Gasoline Exhibits.

The New Gasoline Exhibits. Albert L. Clough. Brief illustrated descriptions of recent carriages. 2200 w. Horseless Age —Nov. 6, 1901. Serial. 1st part. No. 44247.

Gasoline Vehicles.

A Year's Development in the Gasoline Class. Perry B. Rawson. Reviews the exhibits at the recent exhibition at Madison Sq. Garden, New York. 3000 w. Horseless Age—Nov. 13, 1901. No. 44355.

Late Practice in Gasoline Vehicles as Indicated by the Show. Albert L. Clough. Discusses speed, prices, tires, driving chains, ignition, lubrication, steering, and brakes. 2500 w. Horseless Age—Nov. 13, 1901. No. 44356.

Light Cars.

The Latest De Dion-Bouton Vehicles. An illustrated detailed description of a new light car with the motor placed in front under a bonnet. The mechanism is fully explained. 3000 w. Autocar—Nov. 9, 1901. Serial. 1st part. No. 44324 A.

Military Tractors.

Competition of Military Motor Tractors Instituted by the British War Office. Gives the rules that are to govern the competition. 1800 w. Horseless Age—Nov. 20, 1901. No. 44455.

Motor Bicycles.

The Future of the Motor Bicycle. J. Lewis Strahan claims that an efficient reliable motor is now available, and calls attention to points in the design of the frames of bicycles that need correcting. 1700 w. Horseless Age—Nov. 6, 1901. No. 44241.

Motor Suspension.

Suspension of Gasoline Motors. Hugh D. Meier. Criticises present practice and suggests improvements that will permit the use of tires having a longer lease of life. 900 w. Horseless Age—Nov. 6, 1901. No. 44240.

Novelties.

Some Novelties in Vehicles and Accessories. Harry E. Dey. An illustrated article calling attention to recent designs and inventions. 2000 w. Horseless Age —Nov. 13, 1901. No. 44354.

Petroleum Vehicle.

The Development of the Petroleum Automobile. Paul Daimler. A review of the life and work of Gottlieb Daimler, the "Father of the Automobile," and an account of the development of the Daimler motor vehicles. 2500 w. Engineering Magazine—Dec., 1901. No. 44573 B.

Quarry Transport.

Heavy Motor Vehicles for Quarry Transport. Discusses the economy of this kind of transport, and gives illustrated descriptions of the various forms of wagons that promise to be of service. 5000 w. Quarry—Nov. 1, 1901. Serial. 1st part. No. 44291 A.

Steam Truck.

The Toledo Four-Ton Steam Truck. Illustrated description of a vehicle for heavy duty which has given good results. 1100 w. Horseless Age—Nov. 20, 1901. No. 44454.

Steam Vehicles.

Steam Vehicles at the Automobile Show. Jos. W. Jones. The present article comments on the Lane automobile, the Morgan water-tube boiler, and other exhibits. Ill. 1200 w. Horseless Age—Nov. 6, 1901. Serial. 1st part. No. 44246.

Style.

Style in Automobiles. Hrolf Wisby. An illustrated article discussing the style developing in the racing automobile and critising the lack of style in most other motor vehicles. 1500 w. Sci Am—Nov. 9, 1901. No. 44228.

HYDRAULICS.

Mine Pumping.

See Mining and Metallurgy, Mining.

Plumbing.

Water Supply in a Block of New York Tenements. Illustrated description of the work done in tenements designed for very low rental, yet providing far better sanitary surroundings than usual. 1600 w. Eng Rec—Nov. 2, 1901. No. 44150.

Pumping Engines.

Duty Trials of Four Holly Pumping Engines, Metropolitan Water-Works. Slightly condensed official report of the duty trials of three 35,000,000-gallon pumping engines at Chestnut Hill, and one 20,000,000-gallon engine at Spot Pond. Ill. 3800 w. Eng Rec—Nov. 16, 1901. No. 44408.

Pumping Engines at Hampton. Two-page supplement and drawings of details with description. 2500 w. Engr, Lond—Nov. 1, 1901. No. 44310 A.

Tests of High-Duty Holly Pumping Engines for the Boston Water Supply. An illustrated description of the plant with report of tests. 4000 w. Eng News—Nov. 14, 1901. No. 44394.

Pumps.

The Suction of Pumps (Die Vorgänge beim Ansaugen der Pumpen). H. Hagens. Discussing especially the suction action of high-speed pumps and the influence of air chambers. 3500 w. Zeitschr d Ver Deutschr Ing—Oct. 26, 1901. No. 44516 D.

Turbines.

Italian Turbines for a Niagara Water-Power Plant. Illustrates and describes the turbines supplying power to the plant of the Hamilton Electric Light & Cataract Power Co. 900 w. Eng News—Nov. 14, 1901. No. 44390.

The Construction of the Buckets of Radial Turbines (Zur Konstruktion der Laufräder Radialturbinen). N. Baashuus. A graphical method of laying out the curves of the buckets of wheels of the Francis type. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 9, 1901. No. 44523 D.

The New Turbines for the Niagara Falls Power Company. Illustrated description with a statement of the conditions to be met. 700 w. Eng Rec—Nov. 23, 1901. No. 44496.

Water Power.

A Project for Developing the Water Power of the Des Moines Rapids. Reviews the report of Lyman E. Cooley in the general engineering aspects of the enterprise, its construction and cost. 5600 w. Eng News—Nov. 14, 1901. No. 44395.

MACHINE WORKS AND FOUNDRIES.

Bicycle-Spokes.

Bicycle-Spoke-Making Machinery. Illustrates and describes a set of ingenious automatic machines for stretching, straightening, cutting, screwing, heading and bending. 1700 w. Engr, Lond—Nov. 15, 1901. No. 44622 A.

Castings.

Three Fixtures for Machining a Special Casting. William Doran. Illustrates and describes fixtures for machining a cast-iron bracket. 1200 w. Am Mach—Nov. 21, 1901. No. 44459.

Connecting Rods.

Making Steam Engine Connecting Rods on the Milling Machine. Charles S. Gingrich. Describes an experiment showing the wide applicability of the milling machine. 1300 w. Am Mach—Nov. 21, 1901. No. 44457.

Contraction.

Controlling the Contraction of Metals While Casting. William D. Allen. Abstract of a paper read before the Foundrymen's Assn. of Phila. Illustrates and describes the process. 1200 w. Ir Age—Nov. 14, 1901. No. 44346.

Cost Keeping.

See Industrial Economics.

Crane Hooks.

Crane Hooks. A. E. Holcomb. Table and formulas with directions for use. 400 w. Am Mach—Oct. 31, 1901. No. 44087.

Cranes.

See Electrical Engineering, Power Applications.

Cupolas.

The Foundry Cupola, and How to Manage it. Robert Buchanan. Abstract of a paper read at Dudley meeting of the Staffordshire Iron & Steel Inst. Discusses the designs in use, the blast pressure, and scaffolding, in the present number. 3000 w. Ir & Coal Trds Rev—Nov. 8, 1901. Serial. 1st part. No. 44333 A.

Dies.

A Gang Die and Its Work. William Doran. Illustrated description of a punch and die adapted for the production of a variety of pierced and formed articles. 1000 w. Am Mach—Oct. 31, 1901. No. 44088.

A Small Blanking, Drawing and Bending Die. Describes a tool with a base of only 2½x2 inches which performs three distinct operations—blanking, drawing and bending. Ill. 1200 w. Am Mach—Nov. 14, 1901. No. 44350.

Elevators.

A Graphical Method of Laying Out the Corner of an Elevator Car. F. B. Kleinhaus. Illustrates and describes the method. 500 w. Am Mach—Nov. 14, 1901. No. 44349.

Engine Design.

The Design of Engines of Varying Powers from One Set of Drawings. Prof. H. C. Sadler. Considers the principal conditions which influence the power developed by an engine, and those that govern the sizes of the different parts; then shows a larger or smaller power may be designed from the same drawings. 2000 w. Marine Engng—Nov., 1901. Serial. 1st part. No. 44260 C.

Engine Manufacture.

Some Factors Affecting the Economical Manufacture of Steam Engines. William Thompson. Read at the Glasgow Congress. The points discussed are the premium system, tools, arrangement of tools, shops, standardization, &c. 3500 w. Engs' Gaz—Nov., 1901. No. 44293 A.

Factory Engines.

Steel Forgings for Factory Engines. H. F. J. Porter. Abstract of a paper presented at the 1891 fall meeting of the New England Cotton Mfrs. Assn. Relates the difficulties that presented themselves when this metal was first put to this use, the final success, and the merits of the steel shaft, giving the stand and specifications adopted. Ill. 4500 w. Power—Nov., 1901. No. 44094.

Flanges.

An Emergency Flange. Illustrates and describes an invention for providing a ready means for making good a faulty or broken joint, or fractured pipe in case of emergency, applicable for steam, water, compressed air, or gas mains. 1000 w Col Guard—Nov. 8, 1901. No. 44334 A.

Fly-Wheels.

The Bursting of Small Cast-Iron Fly-Wheels. Charles H. Benjamin. A series of experiments and description of the new apparatus used and the results. Gives conclusions drawn. Ill. 2500 w. Trans Am Soc of Mech Engrs, No. 916—Dec., 1901. No. 44444.

Foundry.

The Relation of the Foundry to Engineering Works. Walter J. May. Considers it an important factor in the economical arrangement of work. 1200 w. Prac Engr—Nov. 1, 1901. No. 44285 A.

What the Engineer Has Done for the Foundry. R. Moldenke. Reviews the improvements introduced in foundry work, giving brief sketches of well known workers in this industry. 2200 w. Ir Trd Rev—Nov. 14, 1901. No. 44378.

Jigs.

A Drill Jig and Its Excellent Work. W. H. Pike, Jr. Illustrated description of a jig which has proved of value in producing work in which great accuracy is required. 500 w. Am Mach—Nov. 21, 1901. No. 44460.

Lathe Driving.

See Electrical Engineering, Power Applications.

Machine Design.

A Weak Point in Machine Design (Eine Stelle an Manchen Maschinenteilen deren Beanspruchung auf grund der Ueblichen Berechnung Stark Unterschätzt Wird). C. Bach. An examination of the weakness of internal angles in machine castings. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 2, 1901. No. 44519 D.

Machine Tools.

A Swedish Miller and Gear Cutter, Boring Machine and Variable Speed Countershaft. Illustrated description. 900 w. Am Mach—Nov. 7, 1901. No. 44266.

Some Examples of the Evolution in Machine Tool Practice. Robert I. Clegg. Reviews the development of the machine shop industry, giving illustrated descriptions of labor-saving machines introduced, and discussing methods adopted in advanced practice. 7500 w. Ir & Trd Rev—Nov. 14, 1901. No. 44379.

The Development of Machine-Tool Building in Germany (Aufgaben und Fortschritte des Deutschen Werkzeugmaschinenbaues). F. Ruppert. An examination of machine details with especial reference to the modifications due to American practice. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 9, 1901. No. 44522 D.

Molding.

Molding Land Rollers. George Buchanan. The method of molding cylinder rollers is illustrated and described. 600 w. Am Mach—Nov. 14, 1901. No. 44351.

Molding Machine.

Bryan Vacuum Molding Machine. H. M. Baldwin. Brief description of the machine and its operation. 1600 w. Ir Age—Nov. 14, 1901. No. 44347.

New Works.

New Offices and Works of the Union Switch & Signal Co. Illustrated detailed description. 1500 w. Ry & Engng Rev—Nov. 9, 1901. No. 44271.

The Works of the Stanley Electric Manufacturing Company. Illustrates and describes the buildings and equipment of a new plant at Pittsfield, Massachusetts. 2200 w. Elec Rev, N. Y—Nov. 2, 1901. No. 44166.

Ornamental Work.

Blanking and Forming a Fancy Shell. Joseph V. Woodworth. Illustrates and describes the method of making, and dies used. 1200 w. Am Mach—Nov. 7, 1901. No. 44264.

Saw Guard.

Improved Safety Guard for Circular Saws (Nouveaux Chapeaux de Surété pour Scies Circulaires). H. Mamy. Illustrating an improved guard which rises to admit the work and closes after it. 1500 w. Génie Civil—Nov. 2, 1901. No. 44504 D.

Shop Labor.

A Bonus System of Rewarding Labor. H. L. Gantt. Describes a system of task work, with instruction cards and a bonus, used in the machine shop of the Bethlehem Steel Co. 6000 w. Trans Am Inst of Mech Engrs, No. 924—Dec., 1901. No. 44448.

Tools.

Some New Machine Tools. Illustrates and describes a cold saw for crank shafts, a six-spindle drill, a two-spindle boring machine, a reaming machine, and a gear cutter. 1000 w. Am Mach—Nov. 7, 1901. No. 44263.

Various Tools and Fixtures. A. H. Cleaves. Brief illustrated descriptions of a jack block, adjustable gage, clamp parts, squaring block, rod-drilling jig, square for planer, &c., &c. 1600 w. Am Mach—Nov. 7, 1901. No. 44262.

Workshop Methods.

Advanced Methods in a British Engineering Workshop. A. Lazenby. A fully illustrated account of the Victoria Works of Willans & Robinson, at Rugby, describing the installation and organization of the establishment, as well as the methods of work. 3500 w. Engineering Magazine—Dec., 1901. No. 44575 B.

MATERIALS OF CONSTRUCTION.

Alloys.

A Study of Copper-Aluminum Alloys (Contribution à l'Etude des Alliages Cuivre-Aluminum). L. Guillet. A comparison of the theoretical formation of these alloys with the results attained in practice. 1200 w. Comptes Rendus—Oct. 28, 1901. No. 44546 D.

Bronze.

Further Researches upon the Relation of the Strength of Bronze to its Temperature (Weitere Versuche über die Abhängigkeit der Zugfestigkeit und Bruchdehnung der Bronze von der Temperatur). C. Bach. A fully tabulated account of Prof. Bach's important and latest results. Zeitschr d Ver Deutscher Ing—Oct. 19, 1901. No. 44511 D.

Manila Rope.

Working Loads for Manila Rope. C. W. Hunt. Gives and discusses three tables showing the results of tests on manila ropes. 1800 w. Trans Am Soc of Mech Engrs, No. 917—Dec., 1901. No. 44447.

Testing Machine.

A Belt and Pulley Testing Machine. C. M. Allen. Illustrated description of the apparatus used for making comparative pulley tests and belt tests. 1200 w. Jour Worcester Poly Inst—Nov., 1901. No. 44120 C.

MEASUREMENT.

Engineering Bureau.

A Project for an International Bureau of Engineering Data. Leicester Allen. A discussion of the necessity for fixed electrical and mechanical standards, urging the importance of an international bureau of standardization. 2500 w. Engineering Magazine—Dec., 1901. No. 44577 B.

Instruments.

A Few Meteorological Instruments. George M. Hopkins. Illustrated descriptions of a weather vane, a wind pressure gauge and a rain gauge. 1200 w. Sci Am—Nov. 16, 1901. No. 44367.

Spiral Springs.

Experiments on Spiral Springs. Charles H. Benjamin and Roy A. French. Describes a series of experiments on open springs in compression, made after the permanent set had been removed by forcing them closed solid in a testing machine. Load and deflection were measured, and conclusions stated. 1100 w. Trans Am Soc of Mech Engrs, No. 918—Dec., 1901. No. 44449.

POWER AND TRANSMISSION.

Bearings.

Tests of Roller Bearings. W. H. Booth. Reports some tests made on a new bearing in good order, and discusses the economy. 2900 w. Tram & Ry Wld—Oct. 17, 1901. No. 44186 B.

Cableway.

Shipping Coal by the Aërial Wire-Rope System at Port Morien, Cape Breton. Joseph G. S. Hudson. Abstract of a paper read before the Canadian Min. Inst. An illustrated description of the arrangements. 1000 w. Col Guard—Nov. 1, 1901. No. 44303 A.

Chain Gear.

A Silent Chain Gear. J. O. Nixon. States the objections to chain gearing, and gives an illustrated description of the chain gear developed by Hans Renold, of Manchester, Eng., stating its advantages. 2500 w. Trans Am Soc of Mech Engrs, No. 919—Dec., 1901. No. 44450.

Gear Teeth.

Considerations Affecting the Height of Gear Teeth. Robert A. Bruce. Gives records on squared paper of the results of a large number of calculations from formulas, and shows the importance of the increase of strength which attends any shortening of the normal addendum. 2300 w. Am Mach—Nov. 14, 1901. Serial. 1st part. No. 44353.

Journal Friction.

The Coefficient of Journal Friction (Zapfenreibung, Zapfenkraft und Koëffizient der Zapfenreibung). Dr. Camerer. A mathematical investigation of the action of the forces in a journal bearing, and their influence upon the friction. 1000 w. Zeitschr d Ver Deutscher Ing—Oct. 19. 1901. No. 44513 D.

Lubrication.

Lubrication of Machinery. Notes some of the points most essential in the lubrication of the bearings of modern machinery. Ill. 1600 w. Mod Mach—Nov., 1901. No. 44142.

Power Gas.

Power Gas (Kraftgas). P. Meyer. A general review of the products of various gas producers, and their direct application to motive power. Serial. Part I. 3500 w. Glasers Annalen—Oct. 15, 1901. No. 44-531 D.

The Mond Gas Process (Mond Gas). R. Schöttler. A description of the Mond gas process, with plans of plant and a discussion of its advantages. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 9. 1901. No. 44521 D.

The use of Blast-Furnace Gases in Gas Engines (Verwendung der Hochofengase in Gasmaschinen). F. W. Lürmann. With tabulated analyses of the gases from furnaces in various districts, showing a mean calorific power of 877 calories per cubic metre. 1000 w. Stahl u Eisen—Nov. 1, 1901. No. 44538 D.

Power Plant.

Combined Steam and Hydraulic Power Plant at Richmond, Va. An illustrated description of the plant of the Virginia Electrical Railway and Development Co. 1500 w. Power—Nov., 1901. No. 44092.

Pulleys.

Tools for Machining Pulleys. Joseph Vincent Woodworth. Detail sketches of tools and fixtures for use in the turret lathe. Ill. 1200 w. Mach, N. Y—Nov., 1901. No. 44189.

Shaft Governors.

Modern Forms of Shaft Governor. H. F. Schmidt. Illustrates and describes various forms in use. 2500 w. Am Elect'n —Nov., 1901. No. 44239.

Speed Regulation.

The Determination of the Irregularities of Prime Movers (Ueber die Bestimmung des Ungleichformigkeitsgrades von Kraftmaschinen). Dr. R. Franke. Discussing especially the variations of speed during a single revolution and describing an apparatus for the investigation of speed variations. 5000 w. Elektrotech Zeitschr—Oct. 24, 1901. No. 44561 B.

Spiral Gears.

Spiral Gears. F. A. Halsey. An illustrated series of articles discussing the spiral-gearing problem. The present number is a comparison of spiral gears with spur gears, and the speed ratio. 2000 w. Am Mach—Nov. 14, 1901. Serial. 1st part. No. 44348.

Spiral Gearing Helps. E. M. Willson. Deals only with gears having an angle of spiral of 45 degrees, giving table and illustrations. 1200 w. Mach., N. Y—Nov., 1901. No. 44191.

Turntable.

Adjustable Turntable for Haulage Inclines. From Glückauf. Brief illustrated description of an apparatus designed to overcome the difficulties attending the switching of tubs in and out of haulage inclines. 800 w. Quarry—Nov. 1, 1901. No. 44292 A.

Water Power.

Water Power Development at Hanuawa Falls. Wallace C. Johnson. Gives figures in regard to the flow available; plans and views showing the construction of the dam, canal, waste gates, penstocks, gates, forebay and building, and a description of the wheels, generators, switchboard, transmission lines and the pulp plant, with its grinders, conveyors and water system. 4400 w. Trans Am Soc of Mech Engrs, No. 925—Dec., 1901. No. 44452 C.

Wire Rope.

The Operation of a Wire Rope in Multiple Laps. William Hewitt. An illustrated discussion of the difficulties met and ways of obviating them. 2500 w. Stevens Ind—Oct., 1901. No. 44078 D.

Worm Gearing.

Manufacturing Worms and Worm Gears. W. E. Willis. Illustrates and describes devices used in making small worm gears quickly and correctly. 1400 w. Am Mach—Oct. 31, 1901. No. 44086.

SPECIAL MOTORS.

Binary Engine.

Waste-Heat Auxiliary Engine. A series of pictures showing the latest developments in this engine, with information and report of results. 2000 w. Sci Am—Nov. 2, 1901. No. 44096.

Diesel Motor.

The Diesel Motor. Report of the Committee on Science and the Arts on the invention of Rudolf Diesel, of Munich, Bavaria. Awarding the Elliott-Cresson gold medal. Ill. 3400 w. Jour Fr Inst—Nov., 1901. No. 44226 D.

Gas Engines.

The Nash Gas Engines. Illustrates and describes the large engines installed in the Power Court at the Pan-American Exposition, and their operation. 1400 w. Ir Age—Oct. 31, 1901. No. 44083.

Internal Combustion.

Observations on Internal Combustion Motors (Beobachtungen an Explosionsmotoren). A. Weber-Sahli. With curves showing the gas consumption of various motors. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 2, 1901. No. 44520 D.

Valve Gears.

A New Valve Gear for Gas, Steam and Air Engines. Ernest W. Naylor. An illustrated description of a system of puppet valves, opened by the pull of electromagnets and closed by springs, stating the advantages. 1400 w. Trans Am Soc of Mech Engrs, No. 920—Dec., 1901. No. 44451.

STEAM ENGINEERING

Automatic Stokers.

Contract Tests of Automatic Stokers at the General Electric Works, Schenectady, N. Y. A report of elaborate tests made on twelve under-feed automatic stokers and also of a plant of Roney stokers. 4000 w. Eng News—Nov. 7, 1901. No. 44276.

Blowing Engines.

Blowing Engine Construction (Ueber Gebläsemaschinen). H. Braunne. Describing the improved Stupf-Riedler machine, with especial reference to the valve construction. 1200 w. Oesten Zeitschr f Berg u Hüttenwesen—Oct. 26, 1901. No. 44555 B.

Boiler Explosions.

Water-Tube Boiler Explosions in an English Electric Light Station. An account of two explosions at the Sardinia St. Station of Metropolitan Electric Supply Co. of London, with extracts from the Board of Trade report. Ill. 1800 w. Eng News—Nov. 21, 1901. No. 44474.

Boilers.

Instruction for Boiler Attendants. D. B. Dixon. Instructions applying more particularly to horizontal return tubular boilers, but in a general way applicable to all types of steam boilers. 2000 w. Am Mfr—Nov. 7, 1901. No. 44224.

Boiler Test.

See Mechanical Engineering. Automobiles.

Boiler Water.

To Determine the Weight of Water in a Boiler. Lawford H. Fry. Gives an approximate method. 1000 w. Am Engr & R R Jour—Nov., 1901. No. 44103 C.

Clearance.

An Experiment on the Effect of Clearance on the Economy of a Small Steam Engine. Albert Kingsbury. Describes experimental work undertaken to determine the effect of varying clearance upon the steam consumption of a small automatic engine. 1800 w. Trans Am Soc of Mech Engrs, No. 923—Dec., 1901. No. 44453.

Combustion.

Loss in Economy by the Inefficient Combustion of Fuel. A. Bement. On the importance of gas analysis, with illustrated descriptions of instruments used. 3500 w. Am Elect'n—Oct., 1901. No. 44317.

Comparative Practice.

English, American, and Continental Steam Engineering. Philip Dawson. Mr. Dawson's second paper treats specifically of British lighting and traction plants and their equipment, with illustrations of many important stations. 4500 w. Engineering Magazine—Dec., 1901. No. 44572 B.

Cooling Tower.

Commercial Forms of Cooling Tower. C. W. Obert. Illustrated descriptions of various types. 3000 w. Am Elect'n—Oct., 1901. No. 44315.

Water Cooling Towers. B. Franklin Hart, Jr. Explains the use of cooling towers and the principle upon which they operate. 2000 w. Am Elect'n—Oct., 1901. No. 44314.

Dynamo Driving.

Engines for Driving Large Dynamos. Charles Day. Read before the Manchester Assn. of Engrs. Discusses the use of high-speed engines in England, describing a Ferranti engine and considering its advantages and disadvantages. Ill. 4000 w. Elect'n, Lond—Oct. 25, 1901. No. 44127A.

Engine Starting.

Starting a Cross Compound Condensing Engine. Detailed directions of the method to be followed. 4000 w. Power—Nov., 1901. No. 44093.

Exhaust Steam.

A Regenerative Accumulator for Exhaust Steam. Illustrated description of an apparatus receiving exhaust steam from engines having intermittent duty and furnishing low-pressure steam to engines requiring a steady supply. 500 w. Eng Rec—Nov. 9, 1901. No. 44211.

Feed Water.

The Purification of Feed Water. C. E. Stromeyer. A report dealing with results obtained in practical working with various types of purifiers, and remarks on the cleaning of boilers worked without purifiers. 4500 w. Ill. Engng—Oct. 25, 1901. No. 44143 A.

Heating Boilers.

European Heating Boilers. Charles F. Hauss. An article in three parts, describing and illustrating the European heating boilers. 1800 w. Met Work—Nov. 23, 1901. Serial. 1st part. No. 44483.

Power Plant.

The New Boiler Plant of the United Railways & Electric Company, Baltimore. Illustrated description of a very large steam generating station, the notes describing particularly the special details of the boiler plant, coal and ash handling apparatus, and structural steel work. 3200 w. Eng Rec—Nov. 2, 1901. No. 44145.

Power Stations.

New Power Stations of the St. Louis Transit Co. Illustrated detailed descriptions of the stations and their equipment. 5000 w. St Ry Rev—Nov. 15, 1901. No. 44461 C.

Separator.

The "Potter" Mesh Separator and Superheater. Frederick A. Scheffler. Describes the construction of this separator, which is made of a series of copper wire screens in a casing and placed inside the boiler on the outlet. Ill. 900 w. Trans Am Soc of Mech Engrs, No. 921—Dec., 1901. No. 44445.

Specifications.

Specification for Steam, Exhaust, Water and Condenser Piping for an Electric Power Station. A specification intended to cover the complete installation of steam piping, exhaust piping, injection and discharge piping, drain drip, blow-off and boiler feed piping, water piping, &c. 3600 w. Stevens Ind—Oct., 1901. No. 44080 D.

Speed Regulation.

Angular Variation in Steam Engines. P. O. Keilholtz. Report of investigations. Mathematical. 5800 w. Trans Am Inst of Elec Engrs—Oct., 1901. No. 44425 D.

Angular Velocity in Steam Engines in Relation to Paralleling of Alternators. Walter I. Slichter. Discusses variation due to irregularities in the applied force and transmission of that force. 3000 w. Trans Am Inst of Elec Engrs—Oct., 1901. No. 44426 D.

Speed Regulation of Prime Movers and Parallel Operation of Alternators. C. P. Steinmetz. Read before the Am. Inst. of Elec. Engrs. A discussion of the effect of permanent variations of rotative speed due to a change of load, temporary variations and periodic changes. 1200 w. Eng Rec—Nov. 2, 1901. No. 44147.

Steam Distribution.

Steam Distribution for Locomotive Engines. H. T. Herr. Extracts from a paper presented at the N. W. Ry. Club. Deals principally with valve motion, its design and importance. 2900 w. Ry Age—Nov. 1, 1901. No. 44193.

Steam Heating.

Heating Apparatus in St. Louis Schools. Illustrates some of the details of heater coils, especially the construction of the steam header. 600 w. Eng Rec—Nov. 16, 1901. No. 44412.

Heating in a Large Group of Car Shops, Baltimore. Illustrated description of a plant for heating, by the fan system, buildings covering 8.7 acres. The plant embraces 4 fan-heater units, a special application of the Holly system of gravity return, and a water-tube boiler plant of 750 H. P. 1800 w. Eng Rec—Nov. 9, 1901. No. 44213.

Ventilating and Heating the Chicago National Bank. A combination plenum and exhaust system is used for distributing heated air in the basement and the first story, and direct radiation in the rest of the building. Plans. 3300 w. Eng Rec—Nov. 23, 1901. No. 44498.

Ventilating and Heating the Glasgow Art Galleries. Describes a group of buildings equipped with a ventilating and heating system comprising a plenum system of air distribution and a water-tube boiler plant for steam production. 1300 w. Eng Rec—Nov. 16, 1901. No. 44411.

Steam Pipes.

Transverse Stresses in Steam Pipes. A. S. Mann. The problem of calculating these stresses is discussed, and the factor of expansion that the writer has found from repeated measurements to be safe is given with explanation. 2000 w. Am Elect'n—Nov., 1901. No. 44237.

Steam Turbine.

The Steam Turbine. Illustrations with detailed description of the De Laval form of turbine, with editorial and historical review. 4800 w. Compressed Air—Nov., 1901. No. 44419.

Valve Gear.

See Mechanical Engineering, Special Motors.

Wastes.

Neglected Heat Wastes. R. A. Douglass. Discusses losses from radiation, leakages, excessive use of the blow-off for flushing, &c. 2000 w. Am Elect'n—Nov., 1901. No. 44234.

MISCELLANY.

Aeronautics.

Count de la Vaulx Balloon "Mediterranéen." A brief account, with illustrations, of the recent attempt to cross the Mediterranean in a balloon. 1100 w. Sci Am Sup—Nov. 23, 1901. No. 44469.

Santos-Dumont Wins the Deutsch Prize. Reviews the work of this aëronaut and his success. Ill. 1000 w. Sci Am—Nov. 16, 1901. No. 44369.

The Roze "Aviator." An illustrated description of the apparatus M. Roze is constructing. 1000 w. Sci Am Sup—Nov. 9, 1901. No. 44232.

The Santos-Dumont Motor Balloon. An illustrated account of the trial made on Oct. 11, when the breaking of the rudder made it necessary to abandon the trip around the Eiffel tower. 1400 w. Autocar—Oct. 19, 1901. No. 44085 A.

Air Resistance.

Modern Theories of Air Resistance. (Die Luftwiderstandsgesetze in Neuster Zeit). F. R. v. Loessh. An examination of the laws of air resistance in connection (Die Luftwiderstandsgesteze in Neuster d Oesterr Ing u Arch Ver—Oct. 18, 1901. No. 44526 B.

Ballistics.

The Trajectory of a Rifle Ball (Trajectoire d'une Balle de Fusil). A mathematical study, based upon data from modern weapons. 2500 w. Revue Technique—Oct. 25, 1901. No. 44510 D.

Clock.

A New Remontoir Clock. Illustrated description of a clock mechanism having new features of interest to the designers of fine machinery. 2800 w. Mach, N. Y—Nov., 1901. No. 44190.

Exposition.

Some Novel Features of the Pan-American Exposition. Herbert Croly. An illustrated article discussing the plan and purpose of the exposition and its features of interest. 4400 w. Archt Rec—Oct., 1901. No. 44116 C.

Field Glasses.

The How and the Why of the Porro Prism Field-Glass. Worcester Reed Warner. An illustrated article giving an analysis of the principles involved. 2600 w. Trans Am Soc of Mech Engrs, No. 927—Dec., 1901. No. 44624.

Heating.

European Warm Air Furnaces. Charles F. Hauss. Brief illustrated descriptions of designs, with general remarks. 2500 w. Met Work—Nov. 2, 1901. No. 44123.

Warming a Chapter House. Illustrated description of interesting features in the system used for the Beta Theta Pi Chapter House in Syracuse. 1700 w. Met Wk—Nov. 9, 1901. No. 44182.

Ice Making.

The Ice Producing Plant in Vienna (Die Eisfabrik der Approvisionierungs-Gewerbe in Wien). J. Hermanck. Illustrating and describing the new large plant in Vienna, using carbonic acid gas. 2000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Nov. 8, 1901. No. 44529 B.

Mechanical Antiquities.

Mechanical Antiquities of America. Edward P. Buffet. The present article gives the history of Henry F. Frasse, an old New York machinist, and his work. Ill. 2200 w. Am Mach—Nov. 21, 1901. Serial. 1st part. No. 44458.

Pens.

The Manufacture of Steel Pens. Describes the making of steel and of gold pens. Ill. 2200 w. Ir & Coal Trds Rev—Nov. 1, 1901. No. 44302 A.

Sugar Machinery.

A Sugar-Cane Triple-Crushing Plant. A. E. Jordan. Describes a sugar-cane-crushing plant erected and in operation at Baliàna, Upper Egypt; the installation is guaranteed to crush 750 tons of cane per day of 22 hours. Ill. 1600 w. Engng—Nov. 8, 1901. 44338 A.

Topical Discussion.

Topical Discussions and Notes of Experience. Prof. F. R. Hutton discusses what it costs to run trains at high speed; Stephen W. Baldwin considers some peculiarities of springs; and F. F. Nickel considers the "Linvolpon" system of units. 2700 w. Trans Am Soc of Mech Engrs, No. 914—Dec., 1901. No. 44443.

MINING AND METALLURGY

COAL AND COKE.

Bituminous Coal.

Burning Bituminous Coal. W. H. Booth. Discusses the difficulties encountered in effecting complete combustion, their causes, and means for remedying them. 3000 w. Mines & Min—Nov., 1901. No. 44220 C.

Briquettes.

Manufacture of Briquettes from Wood Waste. Gustaf v. Heidenstam. Extract from a report of the results obtained by investigations and experiments carried out by the writer, as to the manufacture and carbonization of briquettes from the waste of lumber and saw mills. Ill. 3000 w. Engr, Lond—Nov. 1, 1901. No. 44311 A.

Coal Exports.

See Industrial Economics.

Coal Loading.

Coal-Loading Appliances at Bethune. A. da Cunha, in *La Nature*. Illustrates and describes an installation for loading canal boats from the Marles Colliery. The coal is discharged by gravitation. 8000 w. Col Guard—Nov. 1, 1901. No. 44304 A.

Scotland.

The Hamilton Coalfield. Describes this coal district, one of the most important in Scotland, its deposits, development, mode of working, etc. 3500 w. Ir & Coal Trds Rev—Oct. 25, 1901. No. 44131 A.

COPPER.

Tasmania.

Mining in Tasmania. George A. Waller. A report on the Scamander River and St. Helens. The metals consist principally of copper, tungsten and tin. 9200 w. Aust Min Stand—Sept. 19 and 26, Oct. 3 and 10, 1901. Serial. 4 parts. No. 44286 each B.

Virgilina District.

The Virgilina Copper District. L. N. White. An account of a territory on the Atlantic border giving promise of exceedingly good results. Ill. 4200 w. Min & Met—Nov. 15, 1901. No. 44456.

Wertago.

The Wertago Copper Field. J. B. Jaquet. Reports an examination of this field in New South Wales, considering it capable of yielding a quantity of ore, but impeded by the location, and the lack of water. 1500 w. Aust Min Stand—Sept. 19, 1901. No. 44287 B.

GOLD AND SILVER.

Assay Office.

The United States Government Assay Office at Seattle. A. W. Dee. Concerning the equipment of this office and its method of procedure. Ill. 1700 w. B C Min Rec—Nov., 1901. No. 44472 B.

British Columbia.

Texada Island. William M. Brewer. An illustrated article concerning the northern part of the island. Gold bearing quartz, copper ores, iron and other minerals of value are found. Reports the development of the mines and geological conditions. Ill. 3500 w. Eng & Min Jour—Nov. 23, 1901. No. 44488.

The Snowshoe Mine, Boundary District, B. C. E. Jacobs. An illustrated description of this mine and its development. The ores vary in character. The assay of a representative sample showed gold, silver, copper, iron, lime and silica. 2000 w. Eng & Min Jour—Nov. 23, 1901. No. 44485.

Concentration.

Pneumatic Concentration. E. B. Wilson. Describes the process, and the method of construction and operation of the Hooper concentrator. 1500 w. Mines & Min—Nov., 1901. No. 44217 C.

Dredging.

Gold Dredging in North Georgia. Henry V. Maxwell. Illustrations with brief descriptions of methods. 500 w. Eng & Min Jour—Nov. 2, 1901. No. 44170.

Late Gold-Dredging Practice. Ralph L. Montagu. Describes an attempt to use this method in Montana in 1894, and the difficulties met; also discusses the economic advantages of dredging methods. 2100 w. Min & Sci Pr—Nov. 2, 1901. Serial. 1st part. No. 44181.

The Gold-Dredging Fields of Eastern

Russia. C. W. Purington and J. B. Landfield, Jr. A fully illustrated study of the auriferous gravels of Eastern Russia, showing the favorable conditions for electric mining. 4000 w. Engineering Magazine—Dec., 1901. No. 44576 B.

Klondike.

An English Observer on the Klondike Gold-Fields. From the London *Economist.* Extracts from a letter written by an observer of experience. Considers the alluvial gravels very rich and explains the excessive cost of treating them. 1300 w. Eng & Min Jour—Nov. 23, 1901. No. 44-489.

Korea.

Quartz Mining in Korea. Describes mines and their operation. Ill. 1300 w. Min & Sci Pr—Nov. 2, 1901. No. 44180.

Nevada.

Tonopah. An illustrated descriptive article telling the story of this rich mining district in Nevada. 3000 w. Min & Sci Pr —Nov. 9, 1901. No. 44363.

Nome.

The Season of 1901 at Nome. Herbert Murray. A review of the year and the conditions under which the work has been carried on. 1800 w. Eng & Min Jour—Nov. 23, 1901. No. 44486.

Queensland Ores.

Concentration and Smelting. W. A. Macleod. Deals with the treatment of auriferous ores in Queensland. 2300 w. Aust Min Stand—Sept. 26, 1901. No. 44-288 B.

South Africa.

The Kaffir Miners of the Johannesburg Gold Mines. T. Lane Carter. Describes how they work and how they are managed. Ill. 1600 w. Mines & Min—Nov., 1901. No. 44219 C.

Transvaal.

Mining Outlook in the Transvaal. T. S. Parrott. Discusses the great producing power of this field, the difficulties encountered, the past history, etc. 3300 w. Aust Min Stand—Oct. 10, 1901. Serial. 1st part. No. 44290 B.

Wet Crushing.

A Direct Wet-Crushing Cyanide Mill of the Black Hills. Everett B. Sawyer. Describes the general practice of this mill. Ill. 2800 w. Min & Sci Pr—Nov. 16, 1901. No. 44465.

IRON AND STEEL.

Blast-Furnaces.

Experience with an American Blast Furnace Erected at Mariupol. A. Brezgunow. Condensed translation from *Stahl und Eisen.* Illustrated description with criticisms. 1900 w. Ir & Coal Trds Rev—Oct. 25, 1901. No. 44130 A.

The Eliza Furnace Plant. Illustrated detailed description of this fine plant in Pittsburgh. 3800 w. Ir Age—Oct. 31, 1901. No. 44082.

Chromite.

Chromite or Chromic Iron Ore. Joseph Hyde Pratt. Information concerning chromium, its uses, its source, alloys, etc., where deposits are found, cost, etc. 2800 w. Am Mfr—Nov. 21, 1901. No. 44481.

Deposits.

The Iron Ore Deposits of Gunnison County. Dr. J. Ohly. Describes the deposits, and gives anaylses, discussing the outlook for the development of this field. 1700 w. Min Rept—Nov. 21, 1901. No. 44634.

Iron Industry.

Twenty-five Years of Engineering Progress in the Iron Industry. John Birkinbine. A review of advances, with sketches and photographs of prominent men engaged in the industry. 10,000 w. Ir Trd Rev—Nov. 14, 1901. No. 44374.

Japan.

The Kamaishi Iron Works (Die Kamaishi-Eisenwerke). E. Bahlsen. A general description of an important Japanese iron works, which has been in operation since 1823, using native ores. 2500 w. Stahl u Eisen—Nov. 15, 1901. No. 44542 D.

Liquid Fuel.

The Use of Naphtha Residues in the Iron Works of Russia (Emploi des Residus de Naphte dans les Usines Sidérurgiques de Russie). A. Abraham. Showing the method of using mazout and other petroleum residues for firing boilers and open-hearth furnaces. 2500 w. Génie Civil—Nov. 2, 1901. No. 44505 D.

New Process.

A New Direct Iron and Steel Process. Abstracts of papers describing a new direct process for the production of malleable iron and steel from the ore, invented by J. Rudolph and J. Landin. 1500 w. Col Guard—Nov. 15, 1901. No. 44619 A.

Open Hearth.

A Summary of Development in Open-Hearth Steel. An illustrated review of the various open-hearth furnaces and the changes made in them. 5500 w. Ir Trd Rev—Nov. 14, 1901. No. 44377.

Siemens Open Hearth Steel Furnace. Basil Turner. Describes the Siemens process, the furnace and its operation, dealing mainly with the Lithgow furnace. Ill. 7500 w. Aust Min Stand—Sept. 26, Oct. 3, 10, 1901. Serial. 3 parts. No. 44289 each B.

Rolled Material.

The Development of Rolled Structural Shapes. F. H. Kindl. Reviews the history of rolled material and its applications, discussing the principles upon which the present standards were founded. 4000 w. Ir Trd Rev—Nov. 14, 1901. No. 44376.

Rolling Mills.

Improved Electric Driving for Rolling Mills (Neue Elektrische Antriebe bei Trio-, Blech-, und Universalwalzwerken). A. Schwarze. With especial reference to the operation of the rising and falling tables, and auxiliary machinery for three-high mills, etc. 2500 w. Stahl u Eisen—Oct. 15, 1901. No. 44536 D.

Landmarks in the Rolling Mill History of the United States. William Garrett. Reviews the progress, calling attention to the most striking phases in the development, and giving short sketches of men prominent in the work, with photographs. 9000 w. Ir Trd Rev—Nov. 14, 1901. No. 44373.

The Rolling Mill of the Present (Die Walzwerks-Einrichtungen der Gegenwart). A. Sattmann. A general review of modern rolling mill practice, with especial reference to the specialization of the various departments of the industry. Serial. Part I. 2500 w. Stahl u Eisen—Nov. 15, 1901. No. 44541 D.

Russia.

Anthracite Blast Furnaces in Southern Russia (Die Anthracithochöfen in Südrussland). O. Simmersbach. Giving comparisons of the constitution of American and Russian anthracite, and profiles of furnaces. 1800 w. Stahl u Eisen—Oct. 15, 1901. No. 44537 D.

Santiago Ores.

The Iron Ores of Santiago, Cuba. Arthur C. Spencer. Observations concerning the occurrence and origin of these ores. Ill. 2200 w. Eng & Min Jour—Nov. 16, 1901. No. 44385.

Steel Manufacture.

Twenty-five Years' Progress in the Use of Alloys and Metals in Steel Manufacture. Albert Ladd Colby. A general review of the difficulties which have been overcome in the manufacture and treatment of "special steels," with reference to the important uses. Analyses of the steels and ferro-alloys used are given. Also brief biographical sketches of men prominent in this field. 6300 w. Ir Trd Rev—Nov. 14, 1901. No. 44375.

MINING.

Accidents.

Death by Electricity. Discusses the accident at Exhall Colliery, and discusses electric power services in mines, and the precautions necessary. 3500 w. Col Guard —Nov, 15, 1901. No. 44618 A.

Air Compressor.

The New Collmann Air Compressor at the Harpen Mines at Dortmund (Die Neuen Collman Luft Kompressoren der Zechen "Caroline" und "Vollmond" der Harpener Bergbau Aktien Gesellschaft zu Dortmund). F. Schulte. With a full data of dimensions and performance, and reproductions of indicator diagrams. 1500 w. 1 plate. Glückauf—Nov. 9, 1901. No. 44552 B.

Alaska.

The Ketchikan Mining District, Alaska. William S. Brewer. Gives the boundaries of this district, which includes many islands, producing gold. silver, and copper ores. Describes the country and the difficulties that must be overcome by prospectors. 3000 w. Eng & Min Jour—Nov. 16, 1901. No. 44384.

Laboratory Work.

Notes on Some Work Recently Done in the Mining Laboratories of McGill University. J. B. Porter. Read before the Canadian Min. Inst. An exposition of the methods of teaching . 2500 w. Can Min Rev—Oct. 31, 1901. No. 44167 B.

Malay Peninsula.

Mineral Features of Pahang, Malay Peninsula. F. J. Stephens. Read before the Inst. of Min. & Met., London. Describes the country, its geological features, its minerals, etc. Gold is found in paying quantities, and copper is also found extensively. 2000 w. Eng & Min Jour—Nov. 2, 1901. No. 44171.

Mexico.

Geographic and Geologic Features of Mexico. Robert T. Hill. Notes on their relations to the mineral products. Map. 4900 w. Eng & Min Jour—Nov. 2, 1901. No. 44169.

Old Time Mining in Mexico. O. H. Howarth. Describes the methods and tools used by the ancient miners and their processes of reducing the ore. Ill. 4000 w. Mines & Min—Nov., 1901. No. 44218 C.

The Mining Industries of Mexico. H. L. Geissel. Illustrated account of a rich mining field, the progress in the mining and metallurgical industries, etc. Gold, silver, copper, quicksilver, lead, iron, asphaltum and other valuable products are found. 3000 w. Min & Met—Nov. 1, 1901. No. 44174.

Mine Pumping.

Hydraulic Mine Pumps (Machines d' Epuisement Hydrauliques). M. Seurat. A description of underground hydraulic transmission for the operation of mine pumps, with especial reference to German practice. 2500 w. 1 plate. Génie Civil—Nov. 2, 1901. No. 44503 D.

The Pumping Plant of the Compania Minera y Metalúrgica del Horcajo (Wesserhaltung der Compania Minera y Metalurgica del Horcajo). F. Heerwagen. An illustrated account of the centrifugal pumps at the Horcajo Mine in the province of Ciudad Real, Spain. 4000 w. Zeitschr d Ver Deutscher Ing—Nov. 2, 1901. No 44517 D.

Mining Machine.

The Historical Development of the Pick Type of Mining Machine. L. J. Daft. Historical review noting the changes and improvements that have led to the present machine. General discussion. Ill. 9000 w. Pro Engrs' Soc of W. Penn—Nov., 1901. No. 44421 D.

Mining Plant.

See Electrical Engineering, Power Applications.

Mining Structures.

A Model Tramway and Sampler. James H. Steel. Illustrates and describes the new 250-ton automatic sampler and aërial wire-rope tramway of the Silver King Mining Co., in Utah. Also describes the method of working the plant. 2000 w. Eng & Min Jour. Nov. 9, 1901. No. 44267.

Missouri.

Mining Practice in Southeast Missouri. R. B. Brinsmade. Illustrated description of the country, the mines, and the method of prospecting and working. 5000 w. Mines & Min—Nov., 1901. Serial. 1st part. No. 44214 C.

Rock Drill.

See Elctrical Engineering, Power Applications.

Shaft Sinking.

A piece of Difficult Shaft Sinking in Developing the Salt Mines of Grand Cote Island, Louisiana. J. N. Hazlehurst. A report of this property, its geography, history and development, with an illustrated description of the execution of this work. 3900 w. Eng News—Nov. 7, 1901. No. 44275.

The Removal of Water in Sinking the Schöller Shaft at Libuschin near Kladno. V. Kadainka. Describing the use of compressed air to clear a mine shaft of water during the operation of deepening. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 26, 1901. No. 44554 B.

Shot-Holes.

Stemming Shot Holes. From *Annales des Mines.* Report by the French committee on explosives, on experiments made. Ill. 1700 w. Col Guard—Oct. 25, 1901. No. 44132 A.

Timbering.

The Employment of Iron Bars at the No. 6 Pit, Lens Colliery, France. E. Reumaux. Illustrates and describes the form of bars and method of using them to support the roof while working. 1000 w. Mines & Min—Nov., 1901. No. 44222 C.

Tunnels.

Tunnel Schemes. Arthur Lakes. Compares the Standard, or Cripple Creek, with the Rothsöhnberger Stollen tunnel, of Freiburg, Germany. 2200 w. Mines & Min—Nov., 1901. No. 44221 C.

Turn Table.

Improved Turntable for Inclined Planes (Verstellbare Drehscheibe für Geneigte Bahnen). A description of the "Best" turntable for transferring cars from inclined to horizontal tracks. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 19, 1901. No. 44553 B.

Vancouver.

The Mineral Resources of Vancouver Island. W. M. Brewer. Abstract of an article published in the "Victoria *Times* Royal souvenir number." An illustrated review of its mineral resources and their development. 6000 w. B C Min Rec—Nov., 1901. No. 44471 B.

West Virginia.

Geology of West Virginia. Dr. I. C. White. History and description of the different formations and the minerals found in them. 4000 w. Mines & Min—Nov., 1901. No. 44216 C.

MISCELLANY.

Aluminum.

Aluminum and Bauxite. Joseph Pratt Hyde. On the sources and uses of aluminum. 2000 w. Am Mfr—Oct. 31, 1901. No. 44163.

Diamonds.

The Diamond Deposits of Salobro, Brazil. Prof. F. de Paulo Oliveira. Describes the region and what is known of the deposits, giving an account of the discovery. 2800 w. Eng & Min Jour—Nov. 16, 1901. No. 44386.

Gypsum.

The Mining and Milling of Gypsum in Kansas. W. R. Crane. Describes the gypsum bearing localities and methods of working and treatment. Ill. 1800 w. Eng & Min Jour—Nov. 9, 1901. No. 44268.

Lithographic Stone.

The Production and Consumption of Lithographic Stone. S. J. Kubel. Abstract of a paper in *Mineral Resources of the United States,* 1900. Concerning the sources of supply, and investigations of stones in the United States. 1600 w. Eng & Min Jour—Nov. 23, 1901. No. 44490.

Petroleum.

Casing and Tubing for Oil Wells. Illustrated discussion of types used, and the abuse to which the casing is subject. 1700 w. Am Mfr—Oct. 31, 1901. No. 44162.

Oil Springs of Rio Blanco County, Colorado. Arthur Lakes. Illustrated description of the Whiskey Creek oil region, with analyses of the oil. 3500 w. Mines & Min—Nov., 1901. No. 44215 C.

The Present Outlook for the California Oil Industry. W. J. Young. Reviews the production, the work in progress in the oil-fields, and considers the outlook encouraging. 1600 w. Eng & Min Jour—Nov. 23, 1901. No. 44487.

Petroleum from the Beaumont, Texas, Field. Clifford Richardson and E. C. Wallace. Read before the Soc. of Chem. Ind., New York. The extent of the field, with an outline of the methods used in analyzing the product, and general information. 2500 w. Sci Am Sup—Nov. 9, 1901. No. 44231.

The Production of Petroleum in 1900. F. H. Oliphant. Reviews the features of the production in the United States. 2500 w. Am Mfr—Oct. 31, 1901. No. 44164.

Tin.

Tin Supplies. Editorial on the supply in the Malay States, based on information given in the last annual report and claiming that there is no cause for anxiety concerning the future supply. 1300 w. Engng —Nov. 15, 1900. No. 44617 A.

RAILWAYS AND TRAMWAYS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in September. A record of the most prominent railroad accidents during the month, with editorial comments. 3500 w. R R Gaz—Nov. 15, 1901. No. 44398.

Baggage Handling.

Baggage Handling at the Quai d'Orsay, Paris. From the *Revue Générale des Chemins de Fer*. An illustrated description of the method used at this station of the Orleans Railway. 1200 w. R R Gaz—Nov. 15, 1901. No. 44397.

Chicago.

Chicago Committee on Local Transportation. A paper prepared by George C. Sikes containing suggested outlines of street railway franchise renewal ordinances for Chicago, with a description of some of the features of the case. 2300 w. St Ry Rev—Nov. 15, 1901. No. 44464 C.

Despatching.

Train Despatching. Extracts from a paper by C. N. Woodward, read before the New England R. R. Club. Discusses the work and the practice, the men and the service. 2000 w. R R Gaz—Nov. 8, 1901. No. 44281.

Ferry Transfers.

A Railroad Ferry Transfer. Illustrated description of the arrangements for ferrying trains across the Kennebec River, between Bath and Woolwich. 1100 w. Eng Rec—Nov. 23, 1901. No. 44492.

Freight.

Forwarding Companies and Consolidated Shipments. A ruling concerning the right of the railroads to refuse to transport at carload rates, shipments of less than carload lots which have been consolidated, with editorial discussion. 2000 w. Ry & Engng Rev—Nov. 2, 1901. No. 44179.

Goods Conveyance.

The Conveyance of Goods on Electric Trolley Lines. Alfred H. Gibbings. Outlines a system for Great Britain, pointing its advantages. 3600 w. Tram & Ry Wld —Oct. 17, 1901. No. 44187 B.

Handling Crowds.

The Railway Problem as Applied to the Louisiana Purchase Exposition to be Held in St. Louis, A. D. 1903. Charles E. Koons. Suggestions in connection with transportation of exhibits and people, and the general management of affairs. 2000 w. St. Louis Ry Club—Oct. 11, 1901. No. 44076.

The Railway Problem as Applied to the Louisiana Purchase Exposition to be Held in St. Louis, A. D. 1903. George Hannauer. Brief suggestions advising the organization of a separate World's Fair Freight Terminal. 900 w. St. Louis Ry Club—Oct. 11, 1901. No. 44077.

The Railway Problem as Applied to the Louisiana Purchase Exposition to be Held in St. Louis, A. D. 1903. H. J. Pfeifer. Discusses the railroad business in connection with the proposed fair, giving suggestions for the arrangements needed. 4000 w. St. Louis Ry Club—Oct. 11, 1901. No. 44075.

The Railway Problem as Applied to the Louisiana Purchase Exposition to be Held in St. Louis, A. D. 1903. Jno. J. Baulch. Suggestions for the efficient handling of the construction work, transport of materials and exhibits, and prompt transportation of passengers. 3300 w. St. Louis Ry Club—Oct. 11, 1901. No. 44074

The Railway Problem as Applied to the Louisiana Purchase Exposition to be Held in St. Louis, A. D. 1903. William R. Brannan. Outlines the conditions at St. Louis and a plan for satisfactorily caring for the crowds of people expected. 3000 w. St. Louis Ry Club—Oct. 11, 1901. No. 44073.

The Railway Problem as Applied to the Louisiana Purchase Exposition to be Held in St. Louis, A. D. 1903. Discussion of the prize papers on this subject, by A. T. Perkins and others. 3200 w. St. Louis Ry Club—Nov. 8, 1901. No. 44637.

Operation.

The Operation of the "Great Gorge Route." Godfrey Morgan. An illustrated article presenting the facts and problems of operation and maintenance. 2000 w. St Ry Rev—Nov. 15, 1901. No. 44462 C.

FINANCIAL.

Cost Reducing.

Cost Reducing Methods in Railroad and Car Shops. George W. Scott. Discusses the advantage of improved plant facilities, well selected machinery, improved methods, etc. 2000 w. Ry & Engng Rev—Nov. 2, 1901. No. 44178.

Tramways Act.

The Economic Effect of the Tramways Act of 1870. E. F. Vesey Knox. Read before the British Assn. at Glasgow. Gives reasons why the writer believes it to have been the most disastrous legislative experiment attempted in England. 6500 w. Tram & Ry Wld—Oct. 17, 1901. No. 44188 B.

MOTIVE POWER AND EQUIPMENT.

Boston Elevated.

The Boston Elevated Railway. J. A. Stewart. Particulars of interest especially in regard to the recently opened Atlantic Avenue circuit. Ill. 1300 w. Sci Am Sup—Nov. 2, 1901. No. 44097.

Brakes.

Brakes in Railroad and Street Car Service. General discussion of this subject. 23000 w. N Y R R Club—Oct. 17, 1901. No. 44420.

Car Lighting.

The Adlake System of Acetylene Gas Car Lighting. An illustrated description of the apparatus, with an explanation of how the needed conditions have been met. 2800 w. R R Gaz—Nov. 22, 1901. No. 44478.

Works for Rich Gas and Acetylene (Usine à Gaz Riche et à Acétylène). H. Guérin. A description of the plant for generating a rich coal gas, and its further enrichment with acetylene for the carriages of the Paris-Lyons-Mediterranean railway. 1200 w. Génie Civil—Oct. 26, 1901. No. 44502 D.

Cars.

Eighty Thousand Pounds Capacity Tank Cars. Illustrated description of cars for the Atchison, Topeka & Santa Fe Railway for carrying oil or water. 400 w. Am Engr & R R Jour—Nov., 1901. No. 44104 C.

The Vanderbilt Steel Hopper Coal Car, 100,000 Pounds Capacity. Illustrates and describes an interesting car of new design. 1000 w. Am Engr & R R Jour—Nov., 1901. No. 44100 C.

Ceylon.

The Electric Tramway in Colombo, Ceylon. H. S. Morrison. Illustrated description of a line that has been running satisfactorily about three years and is to be extended. 1600 w. St Ry Jour—Nov. 2, 1901. No. 44202 D.

Compound Locomotives.

Valve Gear for Compound Locomotives (Steurung für Verbund lokomotiven). M. Kuhn. Describing a form of valve gear permitting a variable cut-off in the high pressure, and fixed cut-off in the low pressure cylinder. 2500 w. 1 plate. Glasers Annalen—Nov. 1, 1901. No. 44533 D.

Couplers.

The M. C. B. Coupler. R. P. C. Sanderson. A short paper discussing some of its shortcomings and the remedy, with general discussion. 11000 w. W Ry Club—Oct., 1901. No. 44418 C.

Electric Railways.

Electric Traction on the Invalides-Versailles Line (La Traction Electrique sur la Ligne des Invalides à Versailles). F. Drouin. Describing especially the running of the feeders, also the substations and motor cars. 3000 w. 1 plate. Génie Civil—Oct. 26, 1901. No. 44500 D.

Electric Traction on the Main Railway Lines of Switzerland (Elektrischen Betrieb auf den Schweizerischen Hauptbahnen). L. Thormann. A study of the possibility of operating the main Swiss railways by electricity, using water power plants. Serial. Part I. 2000 w. Schweizerische Bauzeitung—Nov. 9, 1901. No. 44558 B.

The Electrification of the Metropolitan and Metropolitan District Railways. A report of the discussion at meeting held to decide what system of electric traction shall be employed. 3500 w. Engng—Nov. 1, 1901. No. 44307 A.

The Electric Motor in Competition with the Steam Locomotive. Editorial discussion of how far the electric motor has proved a success, and a review of several recent papers bearing on this subject. 2400 w. Eng News—Nov. 14, 1901. No. 44393.

Equipments.

Four-Motor Equipments. Gives reasons why many companies prefer to use four motors per car. Ill. 2400 w. Sci Am Sup—Nov. 2, 1901. No. 44098.

Europe.

European Railroad Jottings. Charles Rous-Marten. Describing some recent engines showing a radical reform in freight-train practice in England. Ill. 1600 w. Loc Engng—Nov., 1901. No. 44173 C.

Firing.

Best Method of Firing Locomotives. Gives the report of the committee of the Traveling Engineers' Assn. 1700 w. Ry & Engng Rev—Nov. 16, 1901. No. 44403.

Leeds.

City of Leeds Electric Tramways. Illustrated detailed description of the present tramway system. 3200 w. Tram & Ry Wld—Oct. 17, 1901. No. 44183 B.

Line Polarity.

Freaks Due to Reversal of Line Polarity. Two instances are given in illustration. 1500 w. Am Elect'n—Oct., 1901. No. 44320.

Locomotive Balancing.

The Balancing of Locomotives. Prof. W. E. Dalby. Explains and illustrates a convenient semi-graphical method of obtaining the magnitude and position of the balance weights, and the different ways of dealing with the reciprocating masses in coupled engines, considering the effect of the balance weights on the permanent way and on the tractive force of the engine. Ill. 6800 w. Inst of Mech Engrs—Nov. 1901. No. 44614 D.

Locomotive Tests.

Tests of Light and Heavy Locomotives. Tabulated results, showing heavy locomotives to be advantageous when they may be loaded to capacity. 1100 w. Am Engr & R R Jour—Nov., 1901. No. 44102 C.

Locomotives.

A Baldwin Freight Engine of 1847. C. H. Caruthers. Illustrated description. 1300 w. R R Gaz—Nov. 15, 1901. No. 44399.

American vs. British Locomotives in India. A letter from the chief engineer of the Bengal Central Railway, comparing the performance and cost. 500 w. U S Cons Repts, No. 1184—Nov. 8, 1901. No. 44160 D.

A Study of American Locomotives (Etude sur les Locomotives Americaines). J. Oudet. An exhaustive study of the details of American locomotive construction from a French standpoint. Serial. Part I. 15000 w. Revue de Mécanique—Oct. 31, 1901. No. 44534 E + F.

Brooks Locomotive for San Pedro, Los Angeles & Salt Lake Railway. Illustrated description of an oil-burning engine for passenger trains. 250 w. Loc Engng—Nov., 1901. No. 44172 C.

Compound Locomotive, Bulgarian State Railways. Illustration with brief description. 500 w. Engr, Lond—Oct. 25, 1901. No. 44136 A.

Compound Locomotive, Bulgarian State Railways. Sectional drawings and description. 2500 w. Engr, Lond—Nov. 15, 1901. No. 44620 A.

Express Locomotive, Eastern of France Railway. Illustrated description of an engine designed for service from Paris to Belfort, where fast and heavy trains have to be hauled up long gradients of 6 in 1000. 700 w. Engng—Oct. 25, 1901. No. 44138 A.

Foreign-Built Locomotives. Editorial discussion of the American built locomotives sent to England and India. Also considers German competition. 2000 w. Engng—Nov. 8, 1901. No. 44339 A.

Locomotives for India. Editorial on the orders India has given to Germany for locomotives, and the importance to England of foreign industrial competition. 3000 w. Engng—Oct. 25, 1901. No. 44140 A.

Oil-Burning Locomotives on the Gulf, Colorado & Santa Fe. Drawing and information concerning the locomotives equipped for this road. 1500 w. R R Gaz—Nov. 22, 1901. No. 44479.

Pennsylvania Moguls—Classes F-3 and F-3-b. Illustrations and brief description of the latter class, with points of difference between this engine and Class F-3. 500 w. R R Gaz—Nov. 1, 1901. No. 44207.

Performance of Class I and Class C Locomotives—New York Central Railroad. Indicator diagrams from both classes, with train data and profiles of the divisions in which the work was done. 500 w. R R Gaz—Nov. 1, 1901. No. 44206.

Prairie Type Passenger Locomotives, Atchison, Topeka & Santa Fe. General description, with illustrations of a design for handling fast and heavy work. Also editorial discussion. 2000 w. R R Gaz—Nov. 22, 1901. No. 44477.

Some Unusual Locomotives. A. B. Eddowes. Illustrated descriptions of types selected for their engineering interest. 9200 w. Pro Engrs' Club of Phila—Oct., 1901. No. 44432 D.

The Power of a Locomotive and Its Steaming Capacity. David L. Gallup. Reports investigations of tractive power made on Boston & Maine wide fire-box locomotives. 1300 w. Jour Worcester Poly Inst—Nov., 1901. No. 44121 C.

Weight and Capacity of Locomotives with Vanderbilt Boilers and Tenders. Editorial discussion of this design as compared with other locomotives. 1800 w. R R Gaz—Nov. 15, 1901. No. 44400.

Multiple-Unit.

The Multiple Unit System of Electric Traction (Traction Electrique à Unités Multiples). A general description of the Sprague system, as used on the Western Railway of France. 1500 w. Génie Civil—Oct. 26, 1901. No. 44501 D.

New York.

Electric Traction on the New York Elevated Railway (Der Neue Elektrishe Betrieb der New Yorker Stadtbahn). A. Hruschka. A general account of the plans for the conversion of the New York elevated railway, including the line, the power house and the electric plant. Serial. Part I. Elektrotech Zeitschr—Oct. 17, 1901. No. 44559 B.

Portsmouth, Eng.

Portsmouth Municipal Electric Tramways. Illustrated description of an overhead system and equipment. 3200 w. Tram & Ry Wld—Oct. 17, 1901. No. 44184 B.

Railway Motors.

The Service Capacity of Railway Motors. N. W. Storer. A reply to an article by A. H. Armstrong in the April number of this journal, criticising a former article by the writer, published in the Jan. number. Also editorial. 4500 w. St Ry Jour—Nov. 2, 1901. No. 44200 D.

Scotland.

The Electric Tramways of Ayr. Illustrates and describes an installation of special interest from the traffic point of view, because the resident population is so small. —28,700. 2900 w. Tram & Ry Wld—Oct. 17, 1901. No. 44185 B.

Storage Batteries.

Storage Batteries and 60-Cycle Railway Rotaries. Edward L. Reynolds. Brief illustrated description of the use of batteries in conjunction with 60-cycle rotary converters by the Hamilton (Ont.) Light and Cataract Power Co. 900 w. St Ry Jour—Nov. 2, 1901. No. 44199 D.

Street Railroad.

The System of the New Orleans and Carrolton Railroad Company. Illustrated detailed description of one of the finest equipped and operated street railway properties in the United States. 3600 w. St Ry Jour—Nov. 2, 1901. No. 44198 D.

Surface-Contact.

The Munich Surface-Contact Tramway. An illustrated description of recent improvements in this system, and the working of the trial line in Munich. 3200 w. Engr, Lond—Oct. 25, 1901. Serial. 1st part. No. 44134 A.

Switchboards.

Modern Electric Railway Switchboard Practice. G. U. G. Holman. Considers the more recent practice in switchboards for railway installations. 8500 w. St Ry Jour —Nov. 2, 1901. No. 44201 D.

Tires.

The Relation of All-Flanged Engine Tires to Track. H. Wilson. Considers the principles involved in the effects of all-flanged tires upon track, giving illustrations. 3200 w. Ry & Engng Rev—Nov. 2, 1901. No. 44177.

Tramway Conversion.

The Conversion of the Budapest Tramways from Horse to Electric Traction (Ueber den Umbau der Budapester Pferdebahn auf Elektrischen Betrieb). L. Spängler. With plans of the city and illustrations of the power stations. Two articles. 6000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—Oct. 18, 25, 1901. No. 44525 each B.

Trolley Lines.

The Development of Trolley Networks in Michigan. Edward J. Hart. An illustrated account of the lines radiating from Grand Rapids and connecting it with the important Lake Michigan ports. 2800 w. Elec Wld & Engr—Nov. 16, 1901. No. 44381.

NEW PROJECTS.

Albuquerque, N. M.

Atchison, Topeka & Santa Fe Improvements at Albuquerque, New Mexico. Illustrated description of extensive improvements including a hotel and station, a freight station, an office building, with an opera house and two large warehouses. 1000 w. Ry Age—Nov. 8, 1901. No. 44255.

High Speed.

High-Speed Electric Railway Traction. C. A. Carus-Wilson. The present article gives an illustrated description of the cars and their equipment, and describes investigations thus far made. 1200 w. Elect'n, Lond—Nov. 1, 1901. No. 44295 A.

New Line.

New Line of the Burlington in Iowa. An illustrated description of the work being done on the revision of the alignment of the tracks, especially describing the portion between Murray and Creston, Iowa. 1600 w. Ry Age—Nov. 22, 1901. No. 44635.

The Rock Island's New Line to El Paso. An illustrated description of important construction work between Liberal, Kan., and Carrizozo, N. M., a distance of about 392 miles. 1000 w. Ry Age—Nov. 8, 1901. No. 44254.

PERMANENT WAY AND BUILDINGS.

Bonds.

Strange Behavior of Flexible Copper Bonds on the Baltimore & Ohio Belt Line. Describes the care used in track construction and gives illustrated description of the behavior of the bonds. Also gives recommendations of Chas. M. Hobbs for applying bonds of the protected type on steam-road tracks. 1400 w. St Ry Jour—Nov. 2, 1901. No. 44205 D.

Clearing Yards.

The Chicago Clearing Yards. Illustrated detailed description of the most extensive system of yard tracks ever constructed at one location. 6000 w. Ry & Engng Rev—Nov. 16, 1901. No. 44404.

Electric Signals.

Electric Signals on Suburban and Interurban Railways. William Pestell. Read before the Am. St. Ry. Assn. Discusses the need, the devices in use, and gives a copy of the resolutions drawn up by a committee appointed by the Mass. St. Ry. Assn. 2000 w. Ry & Engng Rev—Nov. 9, 1901. No. 44272.

Rail Stresses.

Fiber Stresses in Rails Under Moving

Trains. Extracts from a paper by P. H. Dudley, presented at the Sept. meeting of the Pacific Coast Ry. Club, discussing the subject of rail sections and their relations to the permanent way and railway operations. 1400 w. Eng News—Nov. 14, 1901. No. 44392.

Railway Testing.

A Portable Accelerometer for Railway Testing. F. B. Corey. Illustrated description of this instrument and its operation. It is of great practical value to the railway engineer. 2000 w. Trans Am Soc of Mech Engrs, No. 922—Dec., 1901. No. 44446.

Rail Welding.

Automatic Apparatus for Welding Rails by Aluminothermy (Aluminothermisches Schwessverfahren mit Hülfe Eines Automatisch Wirkenden Abstichs). Dr. H. Goldschmidt. Describing the latest appliances for welding rail joints by the heat produced by the combustion of aluminum. 2500 w. Stahl u Eisen—Nov. 1, 1901. No. 44539 D.

Shops.

New Locomotive and Car Shops of Concrete Construction. Illustrates and describes the new shops of the Central Railroad of New Jersey at Elizabethport. 1500 w. Am Engr & R R Jour—Nov., 1901. No. 44101 C.

Stations.

The Modern Railroad Station. Jean Schopfer. Part first is a finely illustrated description of the recently built Quai d'Orsay station in Paris. 4000 w. Archt Rec—Oct., 1901. Serial. 1st part. No. 44115 C.

The New Victoria Station at Nottingham. Illustrated detailed description of the fine joint station used by the Great Central and Great Northern railways. 2600 w. Engng. Nov. 15, 1901. Serial. 1st part. No. 44616 A.

New Union Station at Richmond, Va. Illustrated detailed description of a fine passenger station. 1000 w. Ry & Engng Rev—Nov. 30, 1901. No. 44699.

Sydney Central Railway Station. Gives a block plan showing approaches and roads, as recommended by the N. S. W. Central Station Board. 900 w. Aust Min Stand—Oct. 31, 1901. No. 44732 B.

Terminals.

One Central Railway Terminal for Chicago. R. C. Sattley. A plan for handling all the Chicago railroads in one terminal is presented, its requirements considered, and 3 plates given. Also general discussion. 18000 w. Jour W Soc of Engrs—Oct., 1901. No. 44154 D.

Terminal Problems of Interurban Electric Railways. Editorial on the paper by Ira A. McCormick, read at the last convention of the Am. St. Ry. Assn., and the discussion that followed. 1800 w. Eng News—Oct. 31, 1901. No. 44110.

Tunnels.

Deep-Tunnel Railways. Editorial review of the report of the joint committee appointed to consider the London underground railway question. 3200 w. Engng —Oct. 25, 1901. No. 44139 A.

Maintenance of Railway Tunnels in Great Britain. Arthur Watson. Slightly condensed from a paper published by the Inst. of Civ. Engrs. 3900 w. Eng Rec—Nov. 23, 1901. No. 44494.

See also Civil Engineering, Construction.

Water Service.

Improvement of Water Service on the Union Pacific R. R. An illustrated description of the Ft. Steele pumping station, and brief notes concerning other supplies. 1700 w. Ry & Engng Rev—Nov. 23, 1901. No. 44630.

TRAFFIC.

New South Wales.

New South Wales Railways and Trade. Editorial discussing the progressive development shown in the management of the railways, and the consequent general prosperity. 1700 w. Engng—Oct. 25, 1901. No. 44141 A.

Statistics.

The Tramways of Paris in 1900 (Les Tramways Parisiens en 1900). With tabulated data of the various lines showing the progress of electric traction, analysis of costs, etc. 3500 w. Génie Civil—Oct. 19, 1901. No. 44507 D.

Train Staff System.

The Train Staff System. Describes this English system of controlling the traffic on single-track railroads. Ill. 3300 w. Ry & Engng Rev—Nov. 2, 1901. No. 44176.

Weight.

Has the Increase in Weight of Freight Trains and Locomotives Reached Its Limit? Editorial discussion of this subject, quoting from Mr. Sullivan's address before the Cent. Ry. Club. 1800 w. Eng News—Nov. 28, 1901. No. 44658.

MISCELLANY.

Railway Progress.

Notes on Railway Progress (Mittheilungen über Fortschritte auf Einigen Gebieten im Eisenbahnwesen). H. Diesel. A comparison of early and modern railway carriages, track, etc. Serial. Part I. Glasers Annalen—Nov. 1, 1901. No. 44532 D.

EXPLANATORY NOTE.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.

Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Ingenería. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Científico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Arch Bridges.

Engineering Studies. Part III. English Stone Arches. By Charles Evan Fowler. Size, 7 in. by 10.; pp. 16; plates, 8. Price, 25 cents. New York: The Engineering News Publishing Co.

A series of half-tone plates of well known bridges in Britain—London Bridge, Waterloo Bridge, Chatsworth and Maidenhead Bridges, the new Bridge of Ayr, Broomielaw Bridge, and others, with brief textual description giving the principal data and sometimes commenting upon the engineering or architectural features of the design.

Astronomical Instruments.

A Few Astronomical Instruments from the Works of Warner & Swasey, Cleveland, Ohio, U. S. A. Size, 9½ in. by 12 in.; plates, 36. Published by Warner & Swasey, Cleveland, Ohio.

A series of unusually fine half-tone engravings of telescopes, chronographs, position micrometers, graduating engines, mounted astronomical instruments and noted observatories, exterior and interior views. The text is confined to brief descriptive lines under the several illustrations.

Compressed Air.

Compressed Air—Its Production, Uses, and Applications. By Gardner D. Hiscox, M. E. Size, 6¼ in. by 9½ in.; pp. 882; figures, 545; tables, 40. Price (cloth), $5.00. New York: Norman W. Henley & Co.

A most comprehensive work, designed to bring the literature of compressed air abreast with the rapid progress it has made in practical mechanical operations. Treats of the physical and operative properties of air from vacuum to the liquid form—its thermodynamics, compression, transmission, expansion, uses for power, for refrigeration, and for hygiene, together with the appliances, tools, and machines in which it is used.

Education.

Proceedings of the Society for the Promotion of Engineering Education. Ninth Annual Meeting, Buffalo, 1901. Edited by Frank O. Marvin, Robert Fletcher, and Henry S. Jacoby. Size, 6 in. by 9 in.; pp. 348. Price, $2.50 (to libraries, $2.00). New York: Engineering News Publishing Co.

Addresses and papers at the Buffalo meeting, chiefly discussing the curriculum of engineering schools or educational methods and exercises. A valuable symposium on engineering pedagogy.

Gas Lighting.

Electric Gas Lighting. By H. S. Norrie. Size, 5 in. by 6½ in.; pp. 102; figures, 57. Price, 50 cents, 2s. 6d. New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd.

An elementary descriptive treatise, designed to enable any one of ordinary mechanical ability to construct, or at least to erect and keep in operation, much of the apparatus for lighting gas by electricity from a distance, thus realizing what the author conceives to be one of the great advantages of electric lighting. The chapters treat multiple lighting, wiring, coils and safety devices, lighting of large buildings, the selection of batteries. The book is clearly written.

High Temperatures.

High Temperature Measurements. Translated from the French of H. Le Chatelier and O. Boudouard by George K. Burgess. Size, 5 in. by 7½ in.; pp. 230; figures, 52. Price, $3.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

A faithful rendering into English of M. le Chatelier's work, with thorough bibliographical and general indices. The scheme of treatment followed is: general principles of thermometry; normal scales and normal thermometers; gas pyrometers; calorimetric pyrometry; electrical-resistance, thermo-electric, heat-radiation and luminous-radiation, and contraction pyrometers; fusible cones, recording pyrometers, and concluding discussion of recent developments.

Hydraulics.

A Treatise on Hydraulics. By Henry T. Bovey, M. I. C. E., LL. D., etc. Size, 6 in. by 9 in.; pp. 582; figures, 330. Price, $5.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Rewritten and largely remodelled from a former edition. The additions and changes are largely in the discussion of pipe flow, accumulators, turbines, and centrifugal pumps.

Index.

The Engineering Index, Vol. III. Five Years, 1896-1900. Edited by Henry Harrison Suplee, assisted by J. H. Cuntz. Size 10 in. by 7 in. Pp. xvi., 1030. Price, $7.50, 30 shillings. New York and London: The Engineering Magazine.

A complete alphabetical index to the technical literature of the closing five years of the nineteenth century, covering the contents of more than 200 periodicals in English, French, German, Italian, Spanish, and Dutch. Each reference is accompanied by a brief descriptive note, giving the general scope of the article, its length, and the date of publication. The work is fully provided with cross references, guiding the searcher promptly and directly to any subject within the scope of the engineering profession. This work is edited from the Engineering Index appearing monthly in The Engineering Magazine for the five years which it covers, the whole having been entirely rearranged and classified alphabetically according to carefully selected catch-words indicating the actual subjects of the articles indexed, and it forms a complete guide to the latest information and most recent practice in engineering as contained in the technical periodical literature of the entire world.

Machine-Shop Practice.

Shop and Foundry Practice. Volume I. Prepared for students of the International Correspondence Schools. Size, 6 in. by 9 in.; pp. 320. Scranton, Pa.: The Colliery Engineer Co.

The first portion of a comprehensive compilation designed to cover modern advanced machine-shop practice, dealing with the subject from the apprentice's or journeyman's point of view, and arranged to accord with a system of teaching technology by correspondence. Based on typical methods and examples taken from the best American works. Volume I treats: Reading Working Drawings; Arithmetic; Measuring Instruments; Lathe Work.

Shop and Foundry Practice. Volume II. The International Correspondence Schools. Size, 6 in. by 9 in.; pp. 452. Scranton, Pa.: The Colliery Engineer.

The second volume of the series defined above, dealing with Working Chilled Iron, Planer, Shaper, and Slotter Work, Drilling and Boring, Milling-Machine Work, Gear Cutting.

Shop and Foundry Practice. Volume III. The International Correspondence Schools. Size, 6 in. by 9 in.; pp. 556. Scranton, Pa.: The Colliery Engineer Co.

The third part of this thorough treatise follows the subject through the operations of Pattern-making, Foundry Work, Blacksmithing and Forging.

Shop and Foundry Practice. Volume IV. The International Correspondence Schools. Size, 6 in. by 9 in.; pp. 430. Scranton, Pa.: The Colliery Engineer Co.

Completing the series of which the former numbers are noticed above, by the exposition of Grinding, Bench, Vise, and Floor Work, General Hints on Shop Practice, and Toolmaking.

The four volumes listed above are not for sale in the usual sense, but are prepared for the use of students taking the course of the International Correspondence Schools.

Reminiscences.

Recollections of a Civil Engineer. By D. H. Ainsworth. Size, 5½ in. by 8 in.; pp. 192. Published by the author, Newton, Iowa.

A naive and picturesque account of personal experience, chiefly in the Western United States during the early era of railway building, beginning with 1850. The fresh color and vigorous handling compensate in great measure for the lack of editorial sense—or sense of proportion—in choosing material for presentation. The book is very entertaining, and has real merit as an informal history of early civil engineering methods and conditions in America.

Sanitation.

Handbook on Sanitation. By George K. Price, M. D. Size, 5 in. by 7½ in.; pp. 317; figures, 30. Price, $1.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The first part deals with the elements of sanitation—air, water supply, sewage disposal, etc.; the second, with sanitary practice in tenement houses, dwellings, public buildings, factories; the third and fourth parts treat of sanitary inspection and sanitary law, and are addressed almost entirely to conditions existing in the United States. The style is concise, and the scheme comprehensive, but the work would gain by being confined more specifically to sanitation proper, with less attempt to ground the reader in elements of general science of which he should be master before he takes up the study of sanitation.

Water Works.

Water Works Distribution. A Practical Guide to the Laying Out of Systems of Distributing Mains for the Supply of Cities and Towns. By J. A. McPherson. Size, 5½ in. by 8 in. Price, $2.50, 10s. London: B. T. Batsford. New York: D. Van Nostrand Co.

This work discusses the general arrangement of distributing systems, including the arrangement of reservoirs and water towers, the laying of mains, the arrangement of valves and fittings, and the methods of recording supply and consumption of water.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

Vol. XXII. FEBRUARY, 1902. No. 5.

THE COMMERCIAL MANAGEMENT OF ENGINEERING WORKS.

By G. Siebert. With an Editorial Introduction.

IN The Engineering Magazine for November, Mr. William D. Ennis made an able argument in advocacy of the engineer's fitness for advance to the executive management of industrial enterprises. In commerce, in manufactures, in transportation, in constructive work, in military affairs, in the navy, there has been enormous and rapid progress in the use of machinery and mechanical appliances—the natural tools of the engineer. Furthermore, what Mr. Ennis termed "the almost invariable consequences of engineering training"—thoroughness, command of details, observation and the comparing of observations, appreciation of the value of continuous records, courage and ability to grapple with new conditions, faculty for organisation, the concept of the fundamental importance of efficiency—these are more and more demanded of the manager of the great undertakings which characterise modern material civilisation. With every increase in the pressure of competition—and that increase is constantly proceeding—these qualities become of yet greater necessity, and Mr. Ennis sees in the training which cultivates them the natural and logical introduction to the lines of advancement leading to chief executive control.

This is a view with which The Engineering Magazine has very close sympathy; but always with the further condition set forth in the introduction to Mr. Carpenter's article on page 693 of this issue—that good executive management must comprehend not only mechanical excellence of product but also practical financial prosperity of the concern under the manager's charge. Lest, therefore, we should contemplate one view so long as to lose sight of other points which must be included in any complete perspective, we gladly give space in the following pages to the complement of the argument by Mr. G. Siebert. For it is, in truth, the complement rather than the controversion of Mr. Ennis' views. The latter sees that the engineer has striking qualifications for filling successfully the post of general manager; the former, that the successful general manager of most modern enterprises must be to a large extent an engineer. The ideals both have in mind are much the same—the roads by which they reach them lead up from opposite sides; or, let us say the finished product is closely alike in both cases, but the order of the processes of manufacture varies in the systems approved by our two contributors.

To a certain extent, the matter may depend on the individual in process of training; efficiency in executive position is the product partly of processes of preparation, partly of qualities inherent in the individuality of the man. It would seem that engineering education and experience were admirably adapted to testing the economy and developing the full efficiency of the human intellectual power plant in a safe and scientific manner before it is put under load; but it is certain that the conditions of the mechanical and manufacturing world today are producing—have produced—a new need for controlling genius, and a new type of intellect and ability to fill the need. The new industrial manager is more than merchant, though he must deal with the economic and financial problems which are peculiarly the merchant's consideration—he is more than engineer in the senses heretofore received, though he must employ and adapt the work of engineers in many specialised lines. He must handle all these elements as forces in the larger applied science of production. The man is here before we have a name for him. Mr. Gunn, in our Works Management Number in January, 1901, suggested the title of production engineer or commercial engineer. According as one regards the commercial or mechanical side of the new science of organised industry, one or the other element of the preparatory training seems more important. Let Mr. Siebert present the argument for the commercial manager.

THE EDITORS.

IF it be a fact that the vast progress of the last half-century is the result of taking the executive management of industrial enterprises out of the hands of merchants and giving it to engineers, it may perhaps be idle to seek for any other answer to the question of the relative fitness of these two classes of men for this work than that given by Mr. William D. Ennis in the November number of THE ENGINEERING MAGAZINE.

It is there contended that the engineer has proved his fitness for executive leadership, and that his technical training gives him a natural claim to such positions. While the educational value of the engineer's practical training cannot be gainsaid, it does not necessarily follow that the members of the mercantile calling lack the abilities and qualifications essential to the successful direction of industrial works, nor that their commercial career may not be just as good a school for the development of these abilities as is an engineering course.

It is indisputable that the achievements of the engineer have had the greatest influence upon industrial growth, but even the engineer himself would, perhaps, have it recognised that this influence is due more to his technical knowledge and ability than to his executive and administrative capacity. The latter may be the case, but it is not necessarily in consequence of his engineering training. While giving the engineer full credit for his technical work, it cannot be denied that the business man has had a large share in making this work of practical value. It has often happened that engineers of undoubted professional ability, when entrusted with the direction of industrial enterprises for developing their own inventions, have been denied that commercial success which was afterwards achieved by the practical business man who took over the management.

If it be really true that the administration of industrial enterprises is now largely in the hands of technical men—which assumption may be found, on closer investigation, to be only partially substantiated—this state of affairs may be a grave danger in times of commercial depression. The engineer and the business man belong to two distinct callings, which, essentially, have really nothing in common. One creates, and represents the progressive tendency; the other conserves, and is the supporting and regulating element. Both are equally important for the prosperity of an industrial undertaking, which can be assured of success only when each recognises the value of the other in the general organisation. The leading business man must therefore be properly co-ordinated with the chief technical official, and at the same time there must be some one in authority over both, with whom rests the final decision in all vital questions.

If the business man exercises functions equally important with those of the engineer, it is but proper that the way to the supreme control should be open to both. The circumstance that the engineer has had a college education does not give him a greater claim to the manager's position, for his training, while sometimes a broad general technical one, may be only one-sided and highly specialised. The young commercial man, if he desires to be abreast of the times—and it is, of course, only such that are here considered—will prepare himself for his calling not only by office work, but also by a course at a modern business college where he will get a theoretical training in administrative problems, finance, economics, commercial law, and statistics in relation to trade in general as well as to a special industry.

The time is past when the commercial man was merely a creature of circumstance, moulded by his accidental surroundings. Today, if he would obtain success, he must be educated or must educate himself, as carefully as the young engineer. Above all, if he wishes to make his mark in industrial life, and does not care to trust to mere chance, he must have a professional training which is not inferior to that of the technical man. His information, aside from the mechanical part of his calling, will not only embrace a thorough understanding of the tendencies of his own land and foreign countries, but he will become an *industrial merchant*—by which name we may distinguish him from the ordinary business man—and as such will devote himself to one branch of industry, in which he will gain at least so much knowledge of the technical processes and the properties of the products as will enable him to discuss them intelligently.

The number of business men who have reached their goal by this rapid path is still small, for not everyone is in a position to choose freely a definite branch of industry, and then to take time for practical work in shops (where the technical student undergoes a long and thorough training), and to attend lectures on the fundamentals of the chosen industry and related ones, and so to acquire most quickly and in the best way that knowledge which is necessary in order to reach the highest positions. Most of these strenuous, far-sighted young business men must acquire this information in a more toilsome way, by keeping their eyes wide open whenever they pass through a shop, by asking questions, and by reading about what they see. That such men are found, whose labours in the interest of their business are fortunately appreciated, will be admitted by every engineer who has had experience of the great loss sustained by an enterprise through the death of a managing director, who, though originally a commercial man, was the soul of the establishment. In this case experience has developed the man of purely commercial training into the industrial merchant. The latter does not and should not have any ambition to take the place of his chief technical officer, or to bother with the details of a machine or with any other purely technical matters; but he is competent to decide all questions which touch the vital parts of the industry, even though they incline toward the technical or technico-administrative side.

While the industrial merchant who rises to the manager's place does not necessarily step outside the circle of his calling, but merely enlarges it, the engineer in a similar position has, in most cases. drawn away from his profession, to which he was originally led by natural inclination, as is stated by Mr. William D. Ennis: "The chief engineer of a large manufacturing company often becomes as little of an engineer (excepting in his methods) as his typewriter."

In order to fill the position of manager properly there is required, besides knowledge, experience and certain personal qualities. The former consists of professional experience and experience of life. The members of no calling have any peculiar advantage in acquiring general worldly experience, in profiting by it, and in making practical application thereof. Whether the prosperity of an industrial enterprise is more enhanced if the manager has acquired his professional experience as an engineer or as a merchant, is a matter of individuality and depends upon each special case. If the commercial and technical authorities, as is most advantageous, work hand-in-hand, the professional experience of both will be available, and the fruit of such experience is shown principally by a rational economy.

The first aim of a business man is to establish the principles of economy and act in accordance therewith, and it is commercial considerations which prompt an engineer to shape his practice efficiently. His profession in itself is less apt to hold him thereto.

Statistical and graphical charts are an aid in the use of which the modern business man is just as expert and intelligent as is the engineer. It is true that the manager who has come from the commercial ranks first learns from these records that there is a lack of efficiency and how to remedy the defect, while the technical director may be able sooner to detect the trouble and abolish it. However, it is the duty of the superintendent to recognise any faults in time, and he can be held responsible. In general, the manager, be he originally a technical or a commercial man, can consider his part done when he has perfected an organisation which permits nothing of importance to escape his final control.

Among the qualities which should be possessed by the director of an industrial establishment may be mentioned: Integrity of character, organising talent, a high sense of duty, practical views joined to energetic ways, and a love of justice. These attributes are born with a man, though they may later be modified by environment. Some may be promoted by engineering training, others by commercial life; but no calling determines them completely.

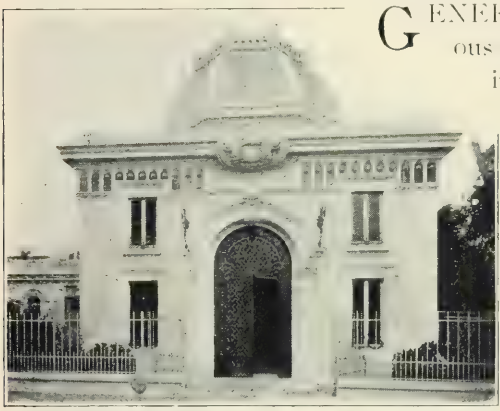
There is therefore no doubt that the industrial merchant is as well equipped for the post of manager as is the engineer. If, in a particular case, one of them is to be preferred, this will naturally be determined by the given circumstances. When such a place is to be filled, however, it should be a fixed rule to consider the members of both engineering and commercial staffs. While engineers are at present successfully occupying such positions, similar results were formerly achieved by managers who rose from the commercial ranks, and many modern instances of the latter kind might be cited.

It may be that there is a lack in industrial life of broadly cultivated commercial officials who are something more than good bookkeepers, accountants, and secretaries—that is, who possess the necessary qualifications for the highest careers in industrial enterprises. But this would show only that there are not enough successors to the old commercial managers to supply the demand, or that their growth has not been sufficiently encouraged. And this, again, may be in consequence of the fact that the wide limits of the field for the commercial man within the great industrial consolidations is not generally enough recognised; that people with an ancient prejudice against the "theoretical" (that is, academically educated) merchant, do not give him an opportunity for that wider development, which is absolutely necessary for him in this rapidly moving era, in order that he may quickly meet the growing demand made upon him to extend his knowledge over industrial matters, and to specialise therein, without renouncing that universal culture which keeps the mercantile calling open to him.

PRACTICAL APPLICATIONS OF REINFORCED CONCRETE.

By Jacques Boyer.

In Professor Boyer's first paper the various systems of reinforcing concrete by imbedded metallic constructions were described in detail, and the methods of erection discussed. After considering the construction of pipes and reservoirs the materials for various branches of work are treated in the present article, together with an account of tests which have been made upon arches and similar structures, followed by descriptions of important works which have been executed in reinforced concrete in various parts of the world.—THE EDITORS.



Casino of St. Enghien, Cottancin System.

GENERALLY speaking, the various systems of pipe construction in reinforced concrete include metallic reinforcements composed of circles or spirals to provide circumferential strength, together with longitudinal rods following the direction of the generatrices, the whole being entirely imbedded in concrete or cement. If the pipes are of moderate diameter they may be constructed in wooden moulds as usual, and connected by suitable sleeves when laid; but large sections may be made in place.

Pipes of this sort at first are not satisfactory, since there is a seepage of water due to the porosity, this porosity, according to M. Gérard Lavergne, ranging from 13 to 33 per cent. of the volume for concrete composed of 250 to 550 kilogrammes of cement per cubic metre of sand. This defect gradually disappears as the calcareous portions unite with the carbonic acid to form an insoluble carbonate of lime, which closes the pores. As a typical example we shall describe the Bonna system, which has been extensively used.

The skeleton of the pipes is very simple, consisting of hoops or rings of iron or steel, within which are placed longitudinal bars (Figure 2.) The network thus formed is then imbedded in concrete of varying thickness. The dimensions of the reinforcements must necessarily be determined by the intended service.

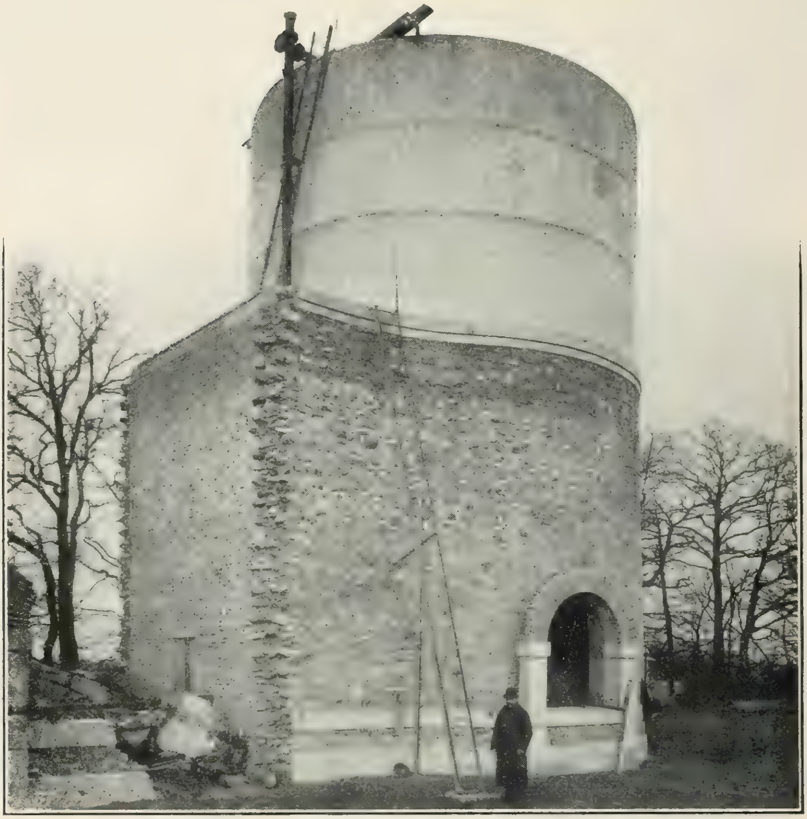


FIG. I. REINFORCED-CONCRETE RESERVOIR, COTTANCIN SYSTEM.

When piping is intended for the distribution of water or gas, M. Bonna has devised a different construction. (Figure 3.) This style, like the preceding, consists of hoops and bars of steel imbedded in concrete, but also contains an internal tube of rivetted sheet steel to provide a lining for the porous concrete. The reinforcement permits this inner tube to be quite thin, while the whole construction resists the action of oxidation in a high degree. The joints of the inner tube are made with short sleeves, packed in the same manner as in the case of ordinary cast-iron pipe. If long continuous sections of pipe are used, it is desirable to use occasional expansion joints, as shown at A. This joint is made of a simple sleeve of sheet steel, packed with rings of rubber and asbestos, these being retained in position by the concrete.

For very large water mains a double reinforcement may be employed, with a lead-lined sheet-iron pipe inside. (Figure 4.) The connecting portions are made either by means of sheet-iron sleeves and concrete, or by light cast-iron sockets. Branch connections to pipes of this kind are readily made, as shown in Figure 5. The external concrete is removed, as well as a portion of the reinforcement, and the cast-iron branch and stop-cock is attached by means of the ring bolts. The joint with the exterior of the pipe is made with a washer of leather, and the interior lead-lined pipe is finally cut through with a chisel.

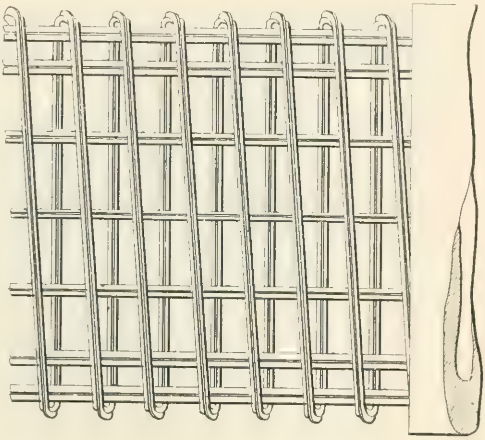


FIG. 2. REINFORCEMENT FOR ORDINARY PIPE, BONNA SYSTEM.

In view of the extensive use which has been made of reinforced concrete pipes in connection with important works of the water service of the city of Paris, this form of construction may be said to have received the sanction of good modern practice. (Figure 6, page 663.)

The conditions under which these were used have brought out some of the principal advantages of the method. Their strength, tightness under pressure, and convenience, have made them acceptable for a great variety of services, including water, gas, drainage,

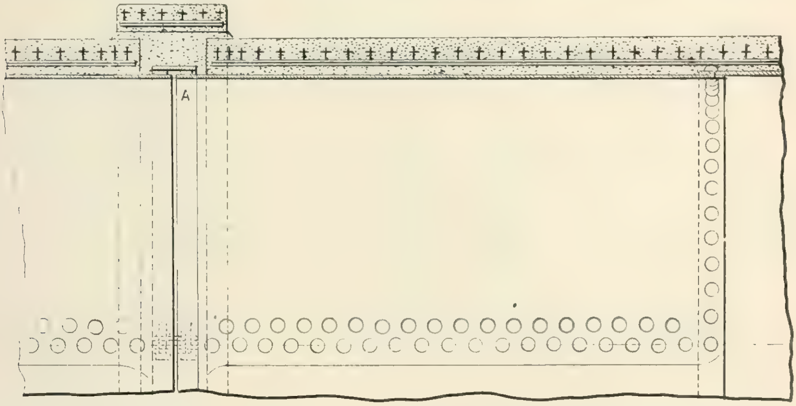


FIG. 3. LONGITUDINAL SECTION OF REINFORCED-CONCRETE PIPE WITH RIVETTED SHEET-STEEL LINING TUBE FOR HIGH PRESSURES. BONNA SYSTEM. THE JOINT IS AT A.

etc. Who knows but that pipes of this construction may ultimately be employed for the pipe-lines of the American petroleum districts?

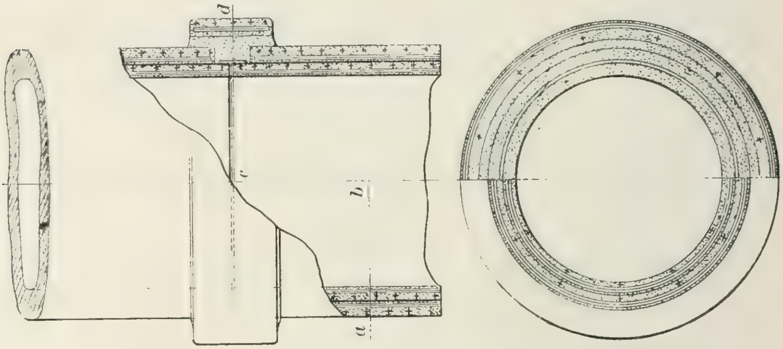


FIG. 4. CONCRETE PIPE WITH DOUBLE REINFORCEMENT FOR HIGH PRESSURE, BONNA SYSTEM.

In the construction of reservoirs M. Cottancin has often adopted the rectangular form, with a spine-rib of metal about the upper part and a number of similar vertical ribs along the sides. If the supports of the structure are in a circle, the reinforcing ribs are placed in three series parallel to the sides of an equilateral triangle inscribed in the circle. On page 660 is shown a reservoir of 300-cubic-metres capacity erected at Versailles by M. Cottancin. On the left side of this it was required to construct an opening of 8-metres span, and the base was there reinforced by metallic ribs and a notable economy effected.

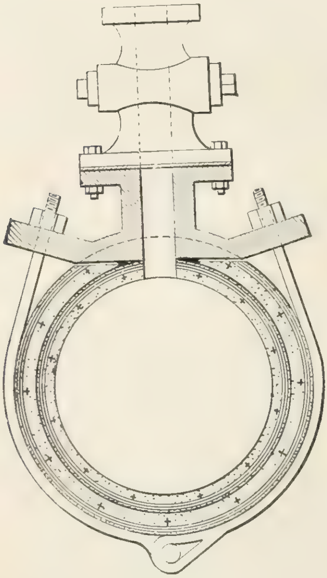


FIG. 5. CONNECTION OF STOPCOCK AND BRANCH WITH A REINFORCED-CONCRETE PIPE MAIN.

The reservoirs constructed by M. Monier are nearly always cylindrical, reinforced by circular or helicoidal rods. When these reservoirs are placed underground the bases and covers are reinforced by radial members or by cross beams forming equilateral triangles. When prismatic forms are employed the rods are inserted so as to strengthen the vertical faces. For a head of 5 metres of water the thickness of the walls at the bottom is made about 12 centimetres, diminishing to 6 centimetres at the

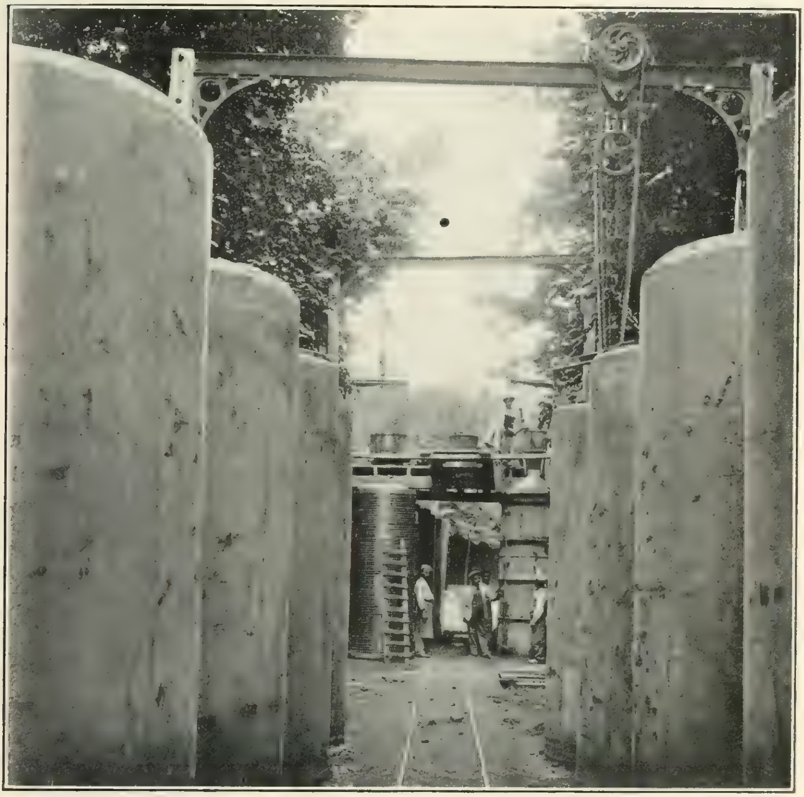
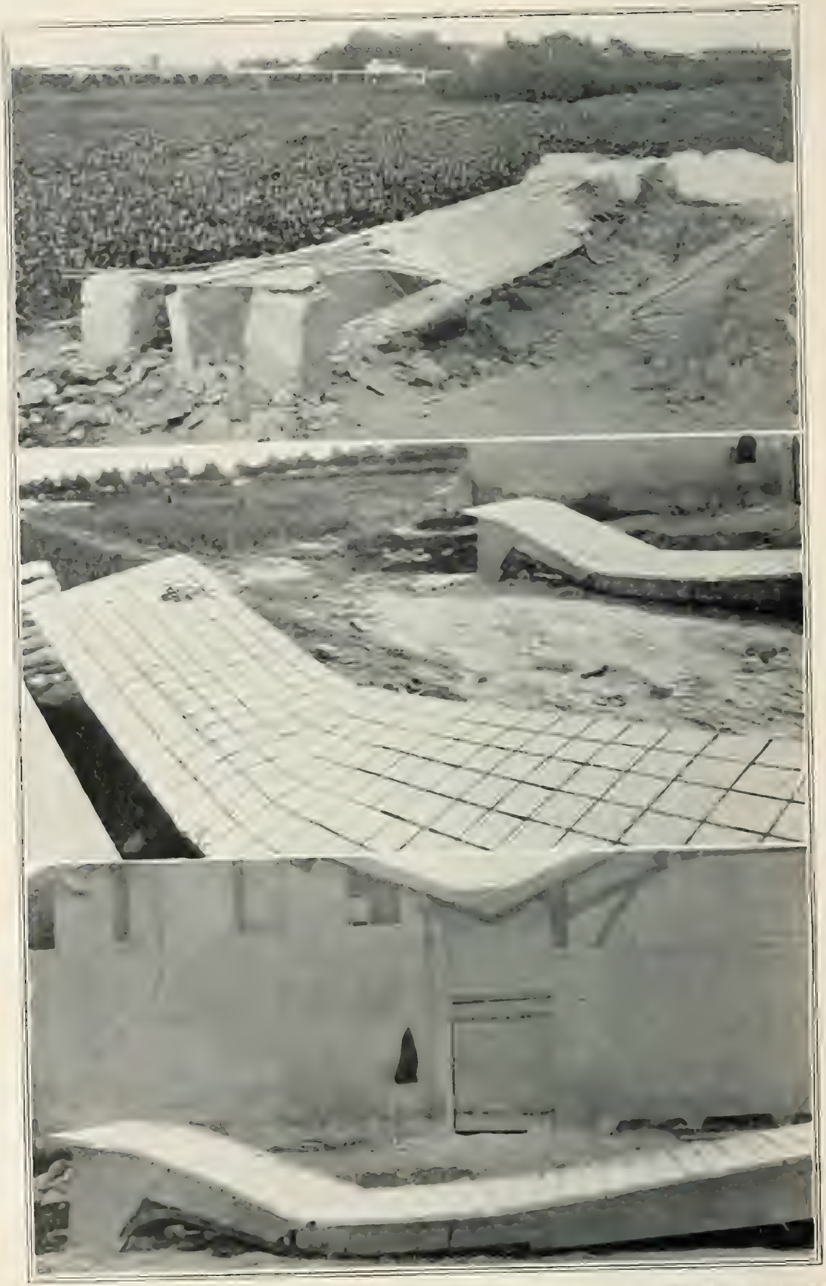


FIG. 6. FACTORY FOR MOULDING PIPES OF REINFORCED CONCRETE, BONNA SYSTEM.

top. In selecting materials for use in works in reinforced concrete, engineers are almost unanimous in their preference for Portland cement. Although the more rapid-setting cements show a higher resistance in a few days, this advantage is soon lost, besides which the composition of the cement is not so homogeneous. The same is true of slag cements, which dry too rapidly, forming thin layers. The composition of the concrete naturally varies with the nature of the work, and some actual data will serve to illustrate.

A concrete consisting of 300 kilogrammes of cement per cubic metre of sand has at the end of six months a compressive resistance of 200 kilogrammes per square centimetre, (2,845 pounds per square inch), while if 600 kilogrammes of cement are used per cubic metre of sand, the resistance is increased to 500 kilogrammes per square centimetre (7,112 pounds per square inch); so that the greater expenditure of cement permits a material reduction in the thickness of walls, partitions, and similar works. In this, as in all similar cases,



FIGS. 7, 8, AND 9. THE TOP VIEW IS THE RESULT OF THE DESTRUCTION OF AN ARCH (NO. 1 SYSTEM, PAGE 666) UNDER A LOAD OF 10,000 KILOGRAMMES; THE MIDDLE VIEW IS A NO. 2. SYSTEM ARCH DESTROYED BY A LOAD OF 12,000 KILOGRAMMES; THE BOTTOM VIEW IS A NO. 3 (COTTANCIN) SYSTEM ARCH CRUSHED BY A LOAD OF 20,000 KILOGRAMMES.

it is necessary to exercise judgment and not to diminish the thickness too far. For ceilings of 10 centimetres in thickness a proportion of 300 kilogrammes of cement per cubic metre of sand appears to be the best. For floors and arches, from 400 to 500 kilogrammes of cement may to advantage be employed to the same proportion of sand, while for light beams or similar work not subject to much loading, and not required to be absolutely water-tight, the proportion of cement may be reduced to 250 kilogrammes per cubic metre of sand. In making heavy slabs, in which strength rather than tightness is demanded, a concrete is made with four parts of gravel or broken stone to one of sand, instead of using sand alone with the cement. When resistance to the pressure of water is required, a mixture of two volumes of cement to three of sand is recommended, or even equal parts of both.

In preparing a reinforced concrete, the sand should be fine and sharp, with angular particles, this being especially important in making pipes and conduits; and, in general, a siliceous sand is to be preferred to a calcareous one. So far as the metal is concerned, both iron and steel are used, according to circumstances. M. Hennebique uses wrought iron for floors and similar horizontal structures, but for walls and vertical work he prefers steel. MM. Coignet and de Tedesco use mild steel, both because of its homogeneous structure and because of its superior strength over wrought iron. The small difference in price has led engineers generally to employ mild steel.

So far as section is concerned, round rod has been much used, and its advantages are thus set forth by M. Gérard Lavergne: It is the cheapest, it occupies the smallest space in ceiling or floor construction, and the concrete is more readily able to fill the interstices in a structure of round rods than in one composed of less simple section. According to M. de Tedesco, however, these advantages disappear in comparison with the practical conveniences offered by rolled sections, arising from the facility with which they can be assembled and secured to each other, and the manner in which a self-sustaining structure can be erected before the filling of concrete is applied.

Tests Upon Structures in Reinforced Concrete:—We will now proceed to examine actual tests which have been made upon various kinds of structures in reinforced concrete, and in order that there may be no question as to partiality we shall refer to the official records. Consider, therefore, the tests made under actual loads, in France, by order of the Minister of War. The following results have been furnished to us by the Technical Commission of the Department of Engineers. In order that the data and results might be comparable, each structure contained the same quantity of metal, cement, and sand, the specimens being divided into three groups according to the various systems:

1:—Systems in which the reinforced rib contained metallic stirrups, connecting the iron bar with the surface of the concrete.

2:—Systems in which small metallic elements were united to lattice-work at the surfaces and stirrups in the ribs, connecting the lower elements to those of the main plate.

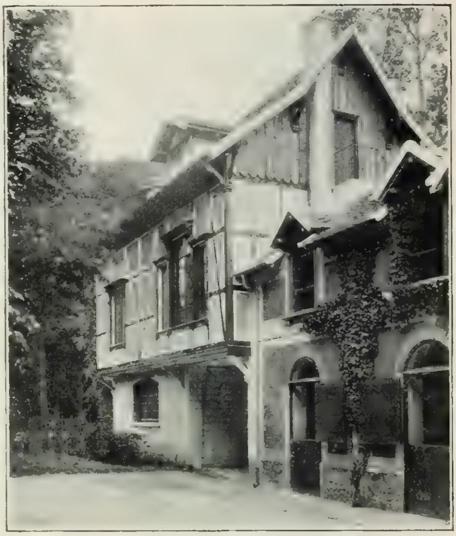


FIG. 10. VILLA BUILT IN REINFORCED CONCRETE, COTTANCIN SYSTEM.

3:—Systems containing wire netting both in the main plate and in the ribs.

Fig. 7 represents a photograph of a specimen of construction of the first class tested to destruction by a load of 10,000 kilogrammes. The nearer example in Fig. 8 shows the manner of rupture of a construction of the second class, under a load of 12,000 kilogrammes, and the breaks show that the materials do not exert their resistance entirely in accordance with the theory. The more distant specimen in the same illustration shows a structure on the Cottancin system, this being shown more fully in Fig. 9. This latter illustration is especially interesting as showing the successful behaviour of the materials. The rup-

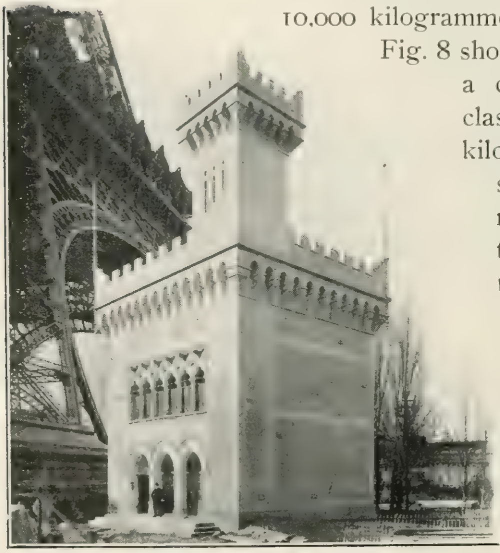


FIG. 11. PAVILION OF THE REPUBLIC OF SAN MARINO, EXPOSITION OF 1900.
Cottancin system.

ture required a load of 20,000 kilogrammes, and took place only after this load had been applied for 45 minutes. The concrete alone was ruptured and the cracks show that the compression and extension forces were resisted to an extent involving nearly the maximum amount of work, much in the same manner as if the beams had been entirely built in to supporting piers. Similar tests have been made upon the Monier and Hennebique systems, with satisfactory results.

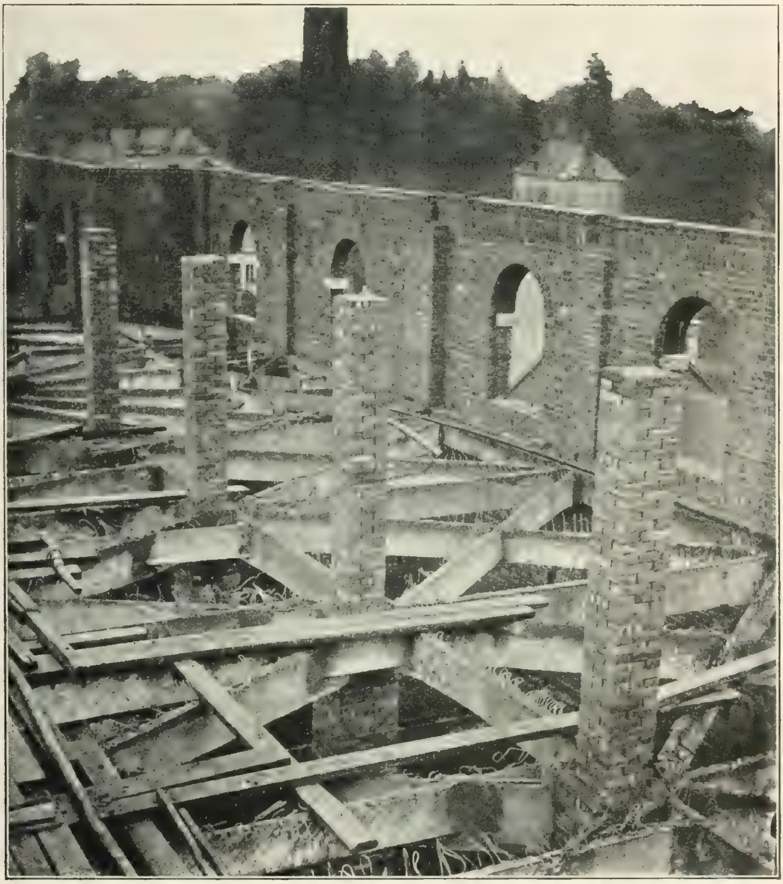


FIG. 12. FLOOR OF A FACTORY, COTTANCIN SYSTEM.

Important Structures which have been Erected in Reinforced Concrete:—We shall now proceed to illustrate a number of structures which have been erected in the various systems, showing its capabilities both for the architect and the engineer. Fig. 10 shows a villa built at Cernay (Seine et Oise) by M. Cottancin. This is a pretty residence with walls of reinforced brickwork, rough-cast on the outside, with wooden panelling, the whole being in the style of an Alsatian chalêt. The floors and interior framing are in reinforced concrete. Fig. 12 shows the details of the method adopted by M. Cottancin for the floors of a workshop erected at La Fère. This is constructed with the reinforced ribs already described, the floor being of reinforced concrete, 5 centimetres in thickness, and capable of sustaining a load of 5,000 kilogrammes per square metre. The piers supporting the floors are of reinforced brickwork, and the building is four stories in height. Another example of workshop construction, executed for M. Schweitzer at Paris by M. Cottancin, is shown in Fig. 13, and is interesting as indicating the manner in which structural difficulties may be overcome. The floor carries a load of 1,000 kilogrammes per square metre, and is supported by piers of reinforced brickwork, 22 by 44 centimetres in cross section. In the illustration the workmen are seen placing the network in position and wiring it to the reinforcing rods of the main ribs, so that the whole forms a complete and continuous skeleton. The construction thus affords a maximum of re-

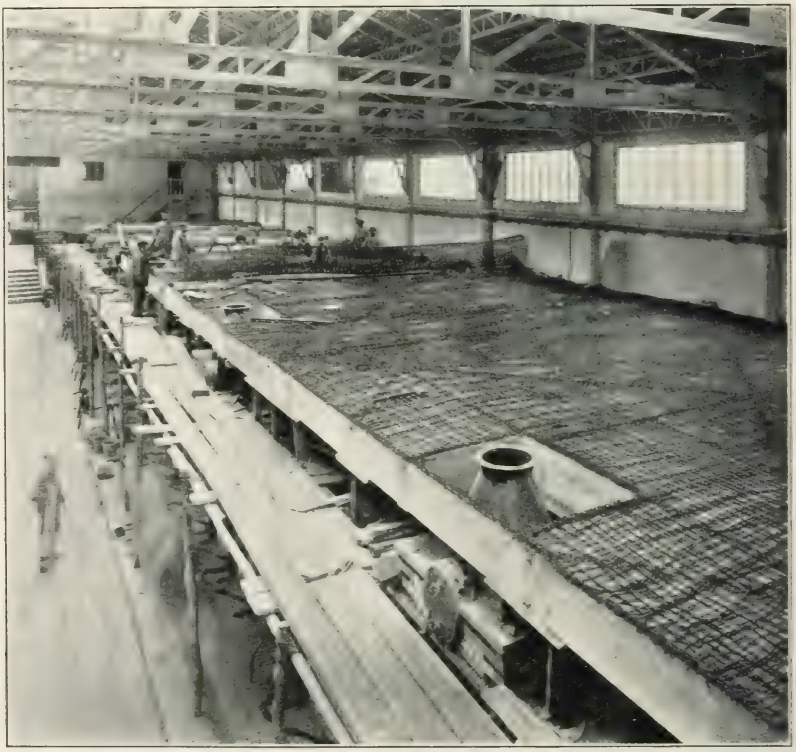


FIG. 13. FLOOR OF THE SCHWEITZER FACTORY, PARIS, COTTANCIN SYSTEM OF CONSTRUCTION.

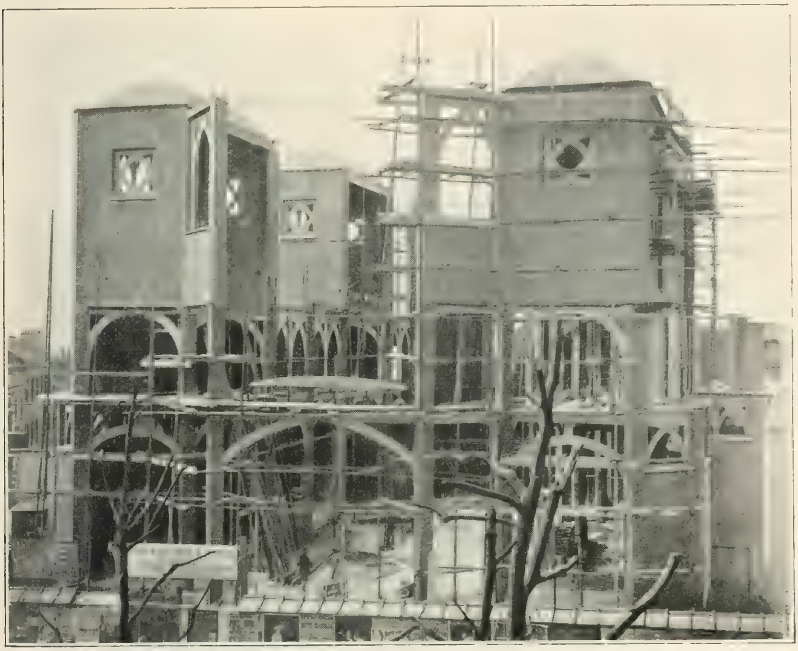


FIG. 14. CHURCH OF ST. JEAN, IN PARIS, BUILT AFTER THE COTTANCIN SYSTEM.
Showing the lightness of the scaffolding employed.

sistance with the use of a minimum of metal. The openings, required by the machinery of the biscuit bakery, are formed by bending the wires back in a manner similar to the formation of a button hole in a woven fabric, this strengthening the structure rather than weakening it, because of the ribs formed about the holes.

Another and different example of reinforced concrete is seen in the pavilion of the Republic of San Marino, (page 666), which stood close to the foot of the Eiffel tower at the exposition of 1900. This was the most economical construction at the exposition, costing but 6 francs per cubic metre, while the minimum cost of the main exposition buildings was 70 francs per cubic metre. The foundations were in the form of an inverted box, resting on the unreliable soil of the Champ-de-Mars, and were composed of reinforced brickwork and blocks of concrete. The walls were 6 centimetres in thickness, without buttresses, and these supported four arches in reinforced concrete which formed the skeleton of the cupola, and which were connected to the battlemented roof, also formed of reinforced concrete, there being skylight openings constructed with reinforced brickwork.

Another remarkable work of this kind is found in the pretty Casino d'Enghien (shown in the initial cut, page 659). This building is erected upon a platform, which is itself supported upon a caisson made of reinforced brickwork filled with earth, this forming a non-deformable base resting upon the soft ground by the border of the lake. The walls are 7 centimetres in thickness, of reinforced brickwork, roughcast in imitation of stone. The dome is made of brick and concrete, with imitation tiles, the whole being treated in a very artistic manner.

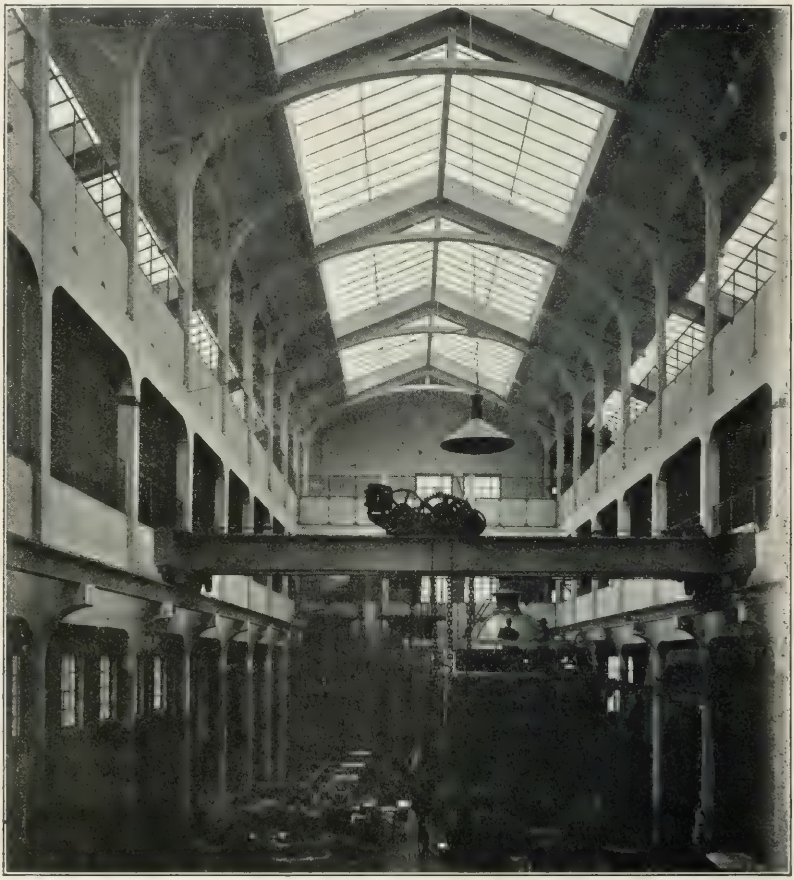


FIG. 15. WORKSHOPS OF SAUTTER-HARLÉ & CO., PARIS, CONSTRUCTED OF REINFORCED CONCRETE ON THE BONNA SYSTEM.

A structure of an altogether different character is found in the church of Saint Jean, in the Montmartre quarter of Paris. The general lines of its construction are shown in Fig. 14. This is an example of ecclesiastical architecture characterised by boldness and economy. The height of the building is 35 metres, and the walls are but 11 centimetres in thickness, the piers being 44 centimetres square. The towers are constructed of reinforced brickwork, with concrete ribbed reinforcements, the space being filled with slag, to form a centering for the outer dome.

The preceding structures are all constructed by M. Cottancin; we now pass to some of the works of M. Bonna. These consist mainly of industrial establishments, and as a typical example we may select the new works constructed for MM. Sautter, Harlé & Cie, Fig. 15 showing the principal bay of the building, the total area covered being about 2,000 square metres. The main bay is 7.20 metres wide and the side galleries 5.45 metres. The outer walls, as well as the pillars supporting the galleries and roof-span, rest directly upon the main floor. In addition the columns support the runway for two travelling cranes, one of which weighs 27,000 kilogrammes. In spite of the difficulties encountered in this structure, a material economy was effected by the use of the Bonna system. M. Bonna has executed a number of other works, among which we may mention a building on the Avenue de la République, in Paris, built entirely of reinforced concrete from cellar to roof; also a shop for the Compagnie des Emeris, of which the skeleton is shown in Fig. 16. He has also constructed the distillery at Conflans-Saint-Honorine, as well as reservoirs for the naval arsenal at Toulon and many other works.

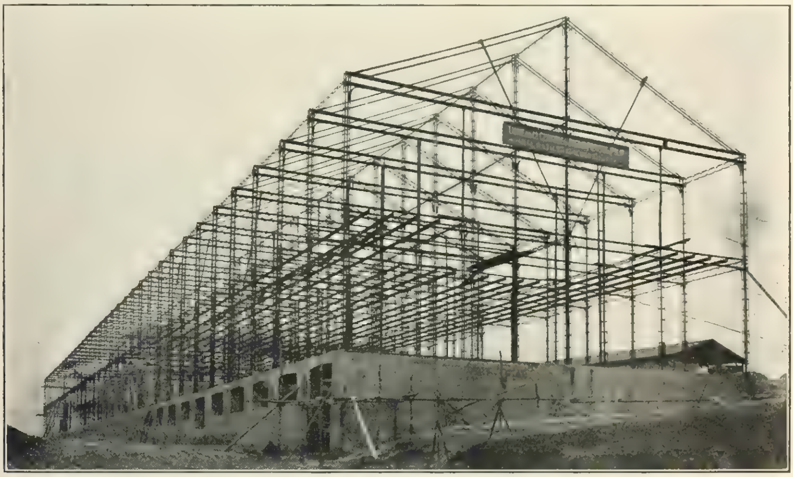


FIG. 16. FACTORY OF THE COMPAGNIE DES EMERIS, BONNA SYSTEM OF REINFORCED-CONCRETE CONSTRUCTION.

The Hennebique system was most creditably represented at the exposition of 1900. The Palais du Costume, the Pavilion of the Colonial Ministry, and of the Colonial Press, among others, were entirely constructed on that system. In the case of the Palais des Lettres, Sciences, et Arts, M. Hennebique constructed the foundations, pillars,

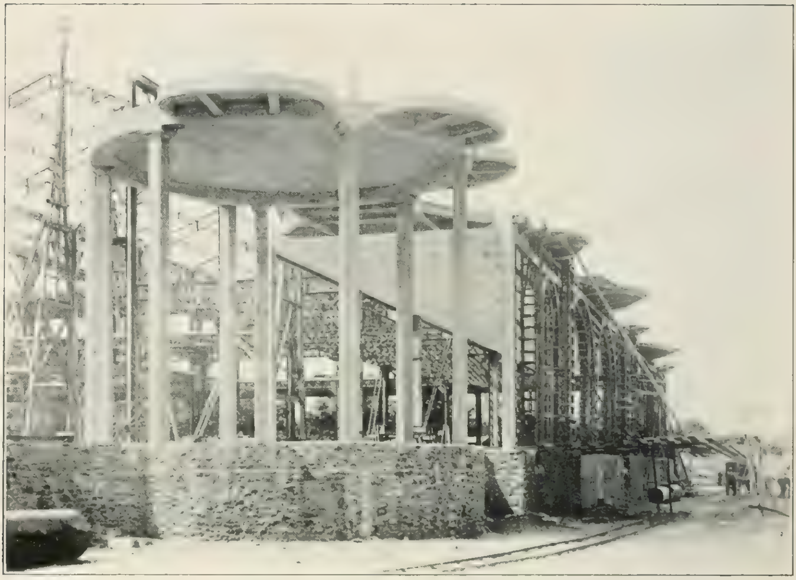


FIG. 17. FOUNDATIONS, COLUMNS, AND CORBELLED FLOORS OF THE PALACE OF SCIENCE, LETTERS AND ARTS, EXPOSITION OF 1900. HENNEBIQUE SYSTEM.

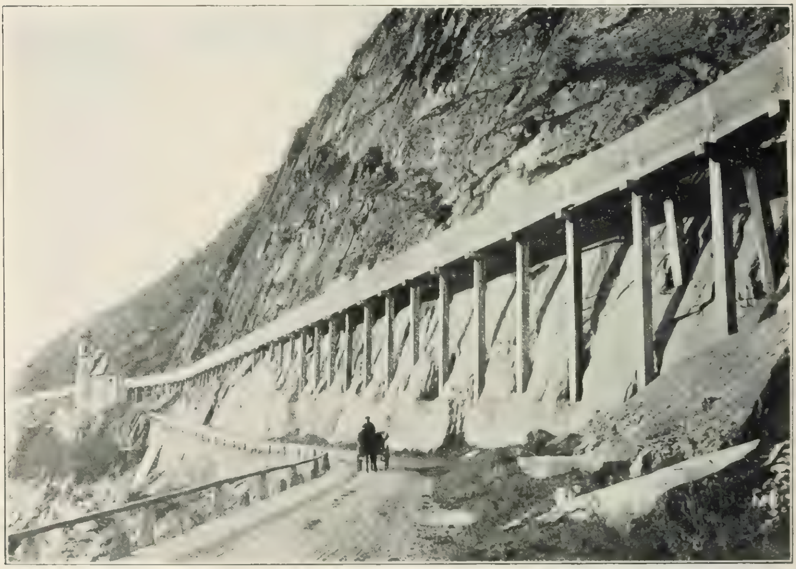


FIG. 18. HENNEBIQUE REINFORCED-CONCRETE FLUME, FOR HYDRAULIC POWER USED IN CUTTING THE SIMPLON TUNNEL.

and corbelling for the outside galleries, Fig 17. The structures have been demolished since the close of the exposition. The Hennebique system has been extensively introduced in other countries than France. At Nice, in the Hotel du Parc Imperial, there are 15,000 square metres of flooring. In Paris the new Cour des Comptes has not only the floors, partitions, etc., made on this system, but also the vaults for the reception of the archives.

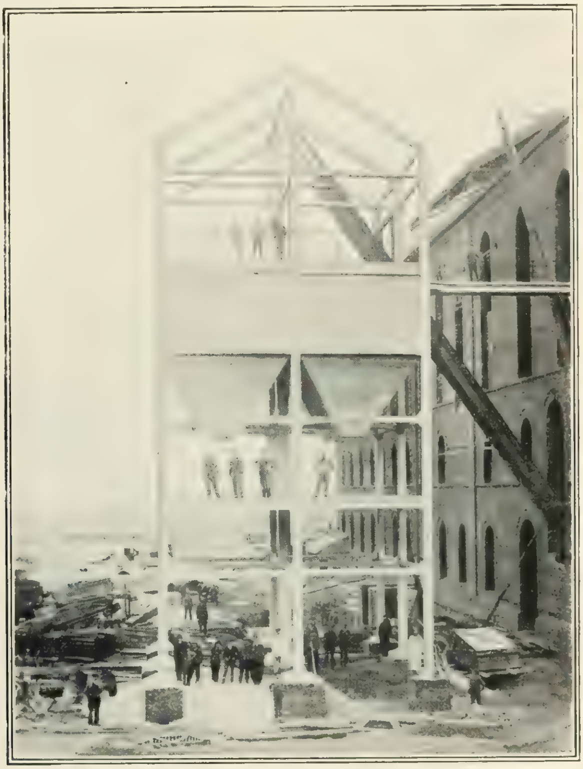


FIG. 19. COKE-STORAGE POCKETS IN REINFORCED-CONCRETE CONSTRUCTION AT ANICHE, NORD.

Among industrial buildings constructed on the Hennebique system, may be mentioned the large mills at Brest (Finistère) page 678, constructed entirely in reinforced concrete, and resting on very bad ground; also the coal bins at Aniche (Nord), these being 8.40 metres above the ground and connected to the main building by a bridge of 7-metre span. At Genoa (Italy) M. Hennebique has constructed a tasteful market building. A very notable example of this system is found in the case of some lime kilns at Luzech (Lot). These have withstood continuously a temperature of 1,200° C. for two years and have required only the most trifling repairs. Another most interesting structure is the flume conveying water to the works on the Simplon tunnel. This is shown in Fig. 18, and is an excellent example of the manner in which reinforced concrete is available in localities where the timber construction would be excessive in cost. This structure is carried along the mountain side upon piers of reinforced concrete, the total length of the flume being 3,200 metres, or about two miles.

Turning now to the subject of bridges, we shall group these also according to their respective constructors. Thus we may mention the bridge constructed in 1899 by M. Bonna, at Auch, across the Gers. This consists of four arches, the total distance being 21 metres. The width is 6 metres, of which 4.50 is for roadway and 0.75 metre for footway on each side, these sidewalks overhanging the structure on each side. The roadway is covered with a wooden paving laid directly upon the concrete flooring which extends across the arches. The arch rings are pierced with openings at the springings in order to make the structure as light as possible, while the thrust is taken by a slab of reinforced concrete 0.13 metre in thickness, slightly inclined in order to present a face normal to the thrust. There are therefore no abutments, properly so-called, these being replaced by an extension of the arches themselves, an entirely novel construction. The reinforcements are symmetrically arranged, and were supported during the erection by bars of flat iron. Tests made by the application of heavy loads upon the completed bridge were remarkable in that they showed

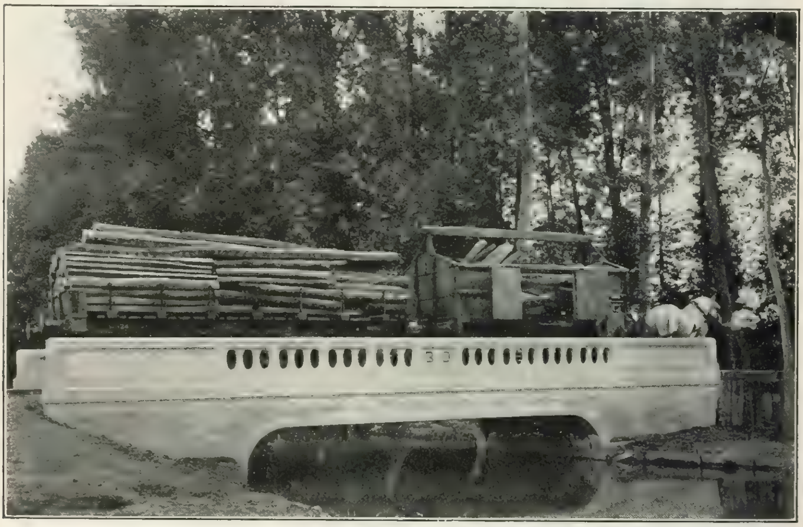


FIG. 20. STRAIGHT BRIDGE BUILT ON THE BONNA SYSTEM.

no appreciable deflection. The cost of the structure was materially less than that of a metal bridge, and the expense of maintenance much smaller. M. Bonna has also constructed a number of flat bridges of moderate dimensions and of original design, of which an example is given in Fig. 20. This is practically a single thick beam of concrete, containing a number of light metal girders.

A remarkable bridge has been erected by M. Hennebique across the Vienne at Châtellerault, Fig. 21. This is composed of three segmental arches in reinforced concrete, one of 50-metres span and 4.50-metres rise, the other two each of 40-metres span and 4-metres rise. The platform of the bridge is carried by vertical pillars resting upon the arches and spaced 2 metres distant from one another, the pillars and platform both being also of reinforced concrete. The sidewalks are 1.05 metres in width, overhanging the main arches.

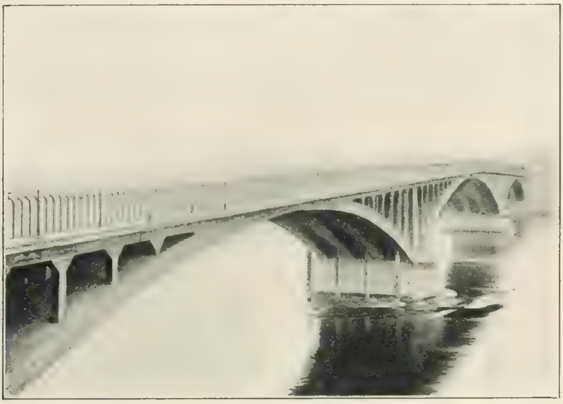
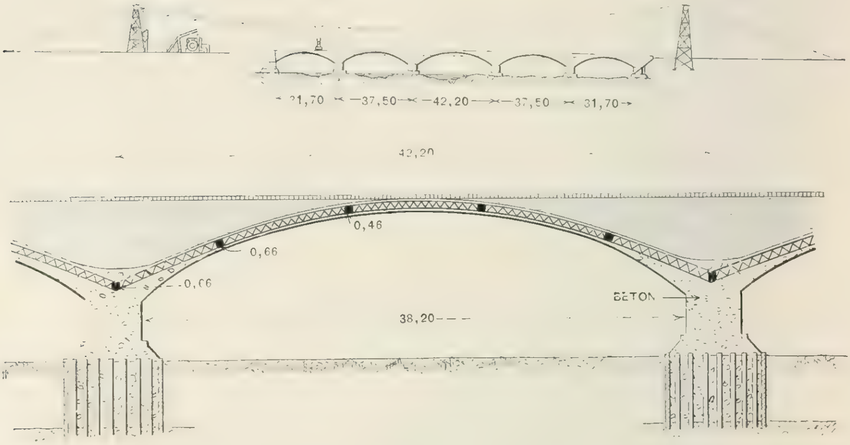


FIG. 21. BRIDGE OF CHATELLERAULT, HENNEBIQUE REINFORCED-CONCRETE CONSTRUCTION.

In Germany, bridges on the Monier system have been in use for some time, both for highways and for railways. This system is the only one patented in the empire, and up to the present time, all attempts to introduce other methods have been ineffective.

The system of the Austrian engineer Melan has been successfully introduced into the United States for bridge construction. This method differs materially from the others, requiring the use of I beams entirely imbedded in concrete. In this way the reinforcement is concentrated into a comparatively small number of members, forming a longitudinal structure of metal having in itself a considerable degree of resistance. The American concessionaries of the Melan patents have gone still further with the idea, and use the metallic structure to reinforce bridges of masonry as well as those of concrete.



FIGS. 22, 23. THE TOPEKA BRIDGE. GENERAL LONGITUDINAL VIEW, SHOWING THE CABLE AND TRAVELER USED IN CONSTRUCTION, AND SECTION OF THE CENTRAL ARCH. DIMENSIONS ARE IN METRES.

An example of Melan construction is given in the bridge across the Kaw river at Topeka, Kansas. This bridge is intended for tramways, vehicles, and foot passengers, and has one span of 42.20 metres, two of 37.50 metres, and two of 31.70 metres. Figs. 22-23. The rise is about one-fifth of the span, and the width is about 12 metres. The thickness of the arch ring is 50 metres at the key and 2.50 metres at the springings, and imbedded in the concrete are the arched lattice girders forming the reinforcement. These are constructed of angle bars 75 by 75 millimetres, and top and bottom chord 200 millimetres wide. The lattice girders are 46 centimetres deep at the crown and 66 centimetres at the springings; the side walls are of concrete, varying in thickness according to the depth from the roadway. The spandrels are filled with earth covered with concrete to form a foundation for the road. In order to provide for the handling of the material, about 20,000 tons, an overhead cableway was employed, with steam operating plant. The total cost of this bridge was $144,000, including the approaches.

General Considerations Concerning Reinforced Concrete:—The new systems of reinforced concrete appear to have been received with favour in various parts of the world. Especially is this construction indicated for workshops, stores, school-houses, and similar buildings in which protection from fire is desired.

Because of the practical identity of the coefficients of expansion of steel and concrete, the adhesion is not affected by variations in temperature. According to Durand-Claye the coefficient for concrete is 0.0000135, and for iron 0.0000130 to 0.0000148.

The use of a malleable reinforcement permits the greatest facility in the construction of the most complicated forms required by the architect. Furthermore, the intimate connections which can be made between the walls, roof, partitions, and floors of a building enable a great solidity to be assured, while at the same time the various parts may be made much lighter than would otherwise be possible. Thus, according to M. Gérard Lavergne, a partition of ordinary bricks on edge weighs 100 kilogrammes per square metre, while one of reinforced concrete, 3 centimetres in thickness, containing rods 5 millimetres diameter, is stronger and weighs but 70 kilogrammes. The rapidity of execution is also an important point in favour of the concrete construction, especially since the materials are so readily obtained and heavy hoisting machinery is not required.

The methods of reinforced concrete construction are especially well adapted for underground work, particularly in humid localities such as cellars, in which external infiltrations are to be expected. In such instances it is necessary only to protect the work with a light outer wall of reinforced concrete. The iron being entirely protected from the moisture there is no danger of loss from oxidation. Even if the iron is partially rusted when it is imbedded in the concrete, a subsequent examination shows that the metal has become cleansed and has recovered its original color. This is doubtless caused by a chemical action, due to the formation of a double silicate around the metal.

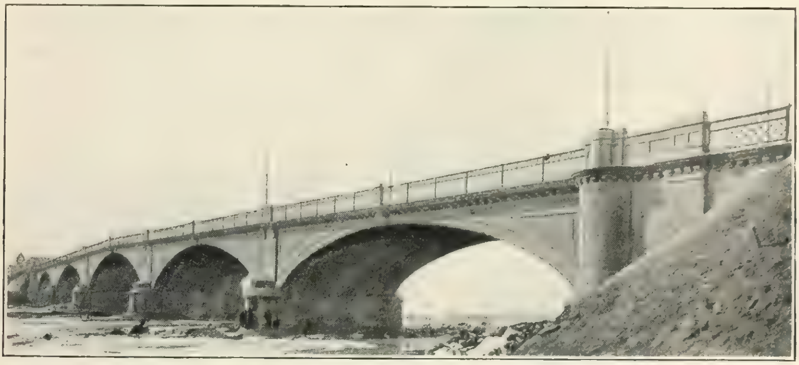


FIG. 24. REINFORCED-CONCRETE BRIDGE OVER THE KAW RIVER, TOPEKA, KANSAS.

The theories involved in the use of reinforced concrete may be briefly sketched as follows:

According to M. Planat, the most rational examination divides the practical cases into three classes. If the load is light, the concrete

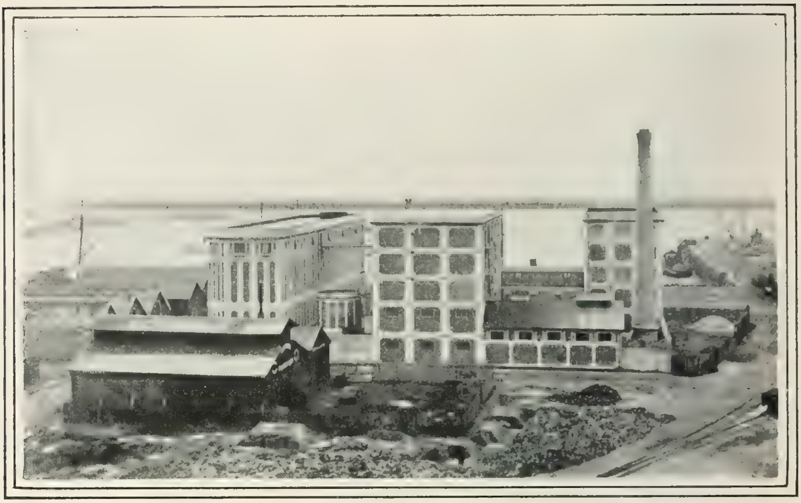


FIG. 25. THE GREAT BREST MILLS, FINISTÈRE. BUILT ON THE HENNEBIQUE SYSTEM.

and the metal remain adhering to each other, subjected to a common deformation. For a moderately heavy load the metallic portions act as tension members, built into the supports at the extremities. When the load becomes excessively large the metallic portions act as suspended cables beneath the structure. From these considerations formulas have been deduced for beams and floors.

As for cylindrical structures, such as pipes and reservoirs, it has become customary to neglect the resistance of the concrete as a whole, and to regard it simply as a means of conveying the pressure to the adjacent members of the metallic skeleton. In the examination of arches it has been found best to work under the hypothesis of a partial separation in the action of the two materials, the metal and the concrete jointly acting to resist tension and compression in the various portions.

Unfortunately, the medal has its reverse side. The resistance of the reinforced concrete depends very largely upon the proportion of cement, the character of the sand, the methods of mixture, and the quantity of water. In order, therefore, to avoid deformations, it is advisable to increase the proportion of reinforcing members, and to increase the thickness over that which has sometimes been adopted. This naturally diminishes the economy of the method. In addition to this warning, it may be added that the best results demand a special kind of skill in the workmen, and consequently involve a proportionally greater expense. Notwithstanding the drawbacks, the method has shown itself to be an important advance in the art of construction.

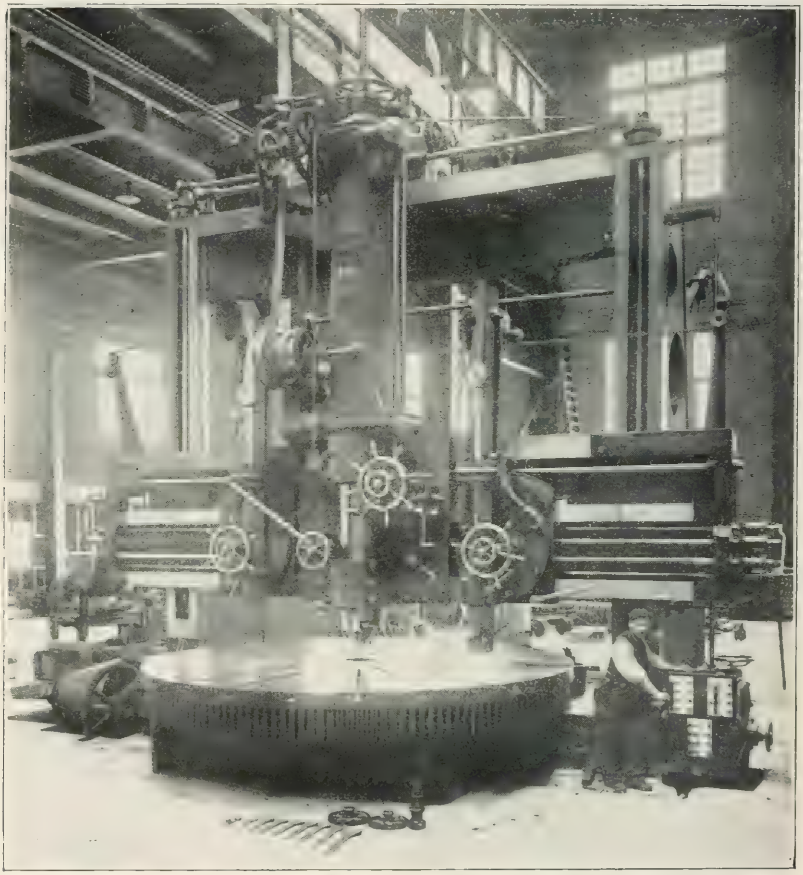
ELECTRIC APPLIANCES IN SHIP-BUILDING YARDS.

By Sydney F. Walker.

The introduction of improved labour processes into ship-building is of peculiar interest because here, even more than elsewhere, economy of manufacture may prove the determining factor in fixing or changing the centres of an enormously important industry. In the following article, Mr. Walker deals principally with applications common to other mechanical industries, but of new introduction into marine construction. A second article will deal with tools and operations more exclusively special to ship-building.—The Editors.

THE great ship-building industry is following the same course, with regard to the adoption of electricity, as other industries. It is feeling its way. Larger and larger apparatus are being entrusted to the care of the electrical engineer, more and more important work is being done by electric-driven machines. Electricity is being more used as its applications are better understood, and as it becomes more reliable. More men of the intelligent mechanic class are becoming sufficiently educated in the knowledge of electrical apparatus to keep them going, and this is producing its usual result—more and more appliances are being used in every industry.

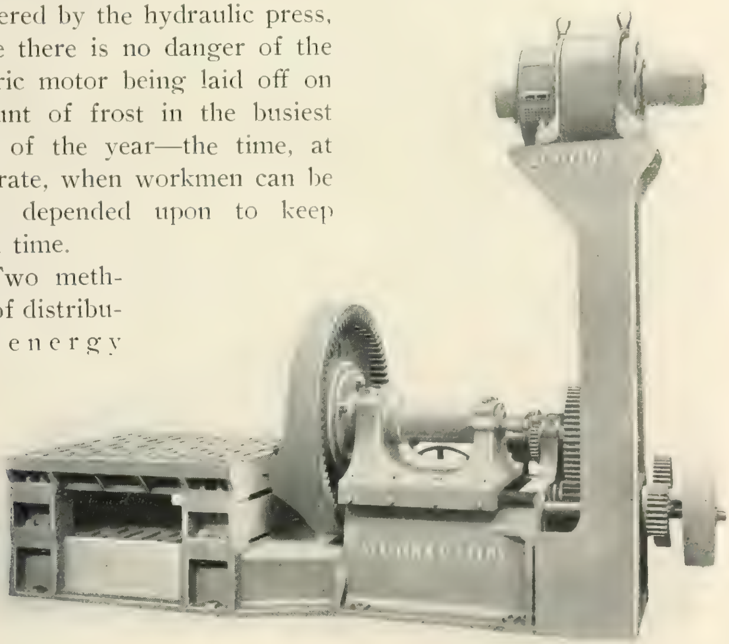
Even now, however, when confidence in electrical appliances has been so far established that tens of thousands of pounds are spent on one installation, the feeling that it is wise to go slow in the matter still prevails to the same extent in all industries, and is shown by the fact that it is rarely thought wise at the present time, in Britain, to use an electric motor exceeding 50 brake horse power. This condition, of course, will pass away. The differences between generators and motors for electrical work are only in their application; and as generators individually converting some thousands of steam horse power into electric energy are in daily use, while the size of the generating units is steadily rising, the question of motors advancing to the same sizes, and larger ones, can be a matter of time and opportunity only. In the



16-FOOT BORING MILL, ELECTRIC DRIVEN, NEW YORK SHIP-BUILDING COMPANY.
Niles Tool Works.

ship-building industry also the struggle which is actively in progress between the rival distributors of energy is well illustrated. Steam, the early form of distributor, is rapidly being relegated to its proper place—the generating power house. Compressed air has not come to the front in the same manner as it has done in mining work, because there is not the danger in connection with the ship-building that there is in mining, and it is only now being introduced, in a small way, in the form of small tools for drilling, rivetting, chipping, and similar work. Nevertheless, if the engineers who have the compressed-air matters in hand are as bold as the electrical engineers, and if compressed air is pushed as much as electricity is being pushed, it must become a very formidable rival to electricity. Hydraulic apparatus, which has justly held its own for so long in ship-building yards, will also continue to be a formidable rival to electricity, and in particular in connection with work, (of which there is so much in ship-building,) in which a large steady pressure is required over a large surface for a short time. Yet even here, a little consideration will show that electricity, properly applied, will render a good account of itself. Hydraulic power has justly displaced steam power, because while the power delivered by a steam engine is necessarily variable through each stroke, that delivered by the hydraulic ram or press is constant within the limits of its useful range. But the power delivered by the steam engine is variable for the same reason that engine-driven plant often causes troublesome vibrations in the neighbourhood—the energy exerted by the piston is constantly varying, and it varies the more the greater the economy that is sought to be introduced. The steam-engine cylinder receives steam during only a portion of its stroke, and for the remainder of the stroke the energy delivered to the piston is constantly falling. With the electric motor, this variation does not exist. Provided the supply service is properly arranged, the motor is of proper size, and other arrangements also as they should be, the energy delivered by the electric motor should be as uniform as that delivered by the hydraulic press, while there is no danger of the electric motor being laid off on account of frost in the busiest time of the year—the time, at any rate, when workmen can be most depended upon to keep good time.

Two methods of distributing energy

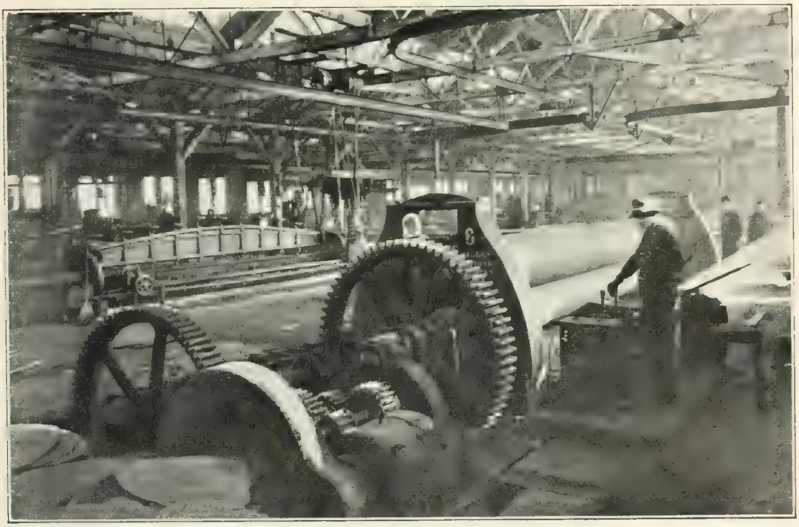


ELECTRIC-DRIVEN MACHINE FOR FACING THE ENDS OF GIRDERS AND COLUMNS.
Takes work up to 30 by 26 inches. Scriven & Co.

that are used in other industries do not seem to have been taken up in ship-building, viz., rope driving and the use of high-pressure producer gas. It is very probable that the former of these will not, at this late date, be introduced into ship-building. It is a formidable rival to some other systems of power distribution in other industries, and might have been in ship-building if it had been pushed in earlier days. Now it would be very difficult to supplant the other methods. Producer gas, especially if delivered at high pressures, may also be a formidable rival. The possibilities of the economy of high-pressure gas are hardly appreciated as yet. The Glasgow exhibition afforded a very striking illustration of its possibilities in the direction of lighting, and power distribution should follow, if gas engineers are not too full of work in other directions. At Glasgow, a large portion of the grounds was lighted by means of Welsbach burners, supplied with ordinary town gas at from 8 to 10 inches water gauge, and the effect was brilliant and the method economical. It is doubtful, however, if the place at which the producer gas should be consumed is not in the cylinders of engines driving electric generators, rather than in individual engines of various sizes. Apart from the question of the efficiencies of small engines worked with gas of any kind, the same question would come up—the uneven turning moment—at least in the case of machines in which hydraulic apparatus is now employed, and it would be necessary to use the gas engine to fill the hydraulic accumulator, just as the steam engine does now. All of the methods enumerated, however closely they may approach electricity in other respects, cannot approach it in the one point which has been the cause, primarily, of its enormous advance during recent years—its great flexibility, or, if the term be preferred, its great convenience. In ship-building this feature is especially valuable, as the work, if it is to be done economically, has to be done in many cases under so widely varying conditions. Or, to put the matter in another form, the ability to do certain portions of the work under certain special conditions, which electricity affords, spells economy very largely.

The building of a ship is probably like nothing else. A ship is a dwelling house, in which men spend a large portion of their lives. It is also a store house, in which are kept the belongings of the crew as well as those of the ship itself, and in which cargo may also have to be stored. The cargo may be of the most various forms, from petroleum in bulk, loose in tanks formed for the purpose, to the equipment of a fighting fort. The house has to conform also to certain conditions in its structure. It has to sit gracefully on, or rather in, the water.

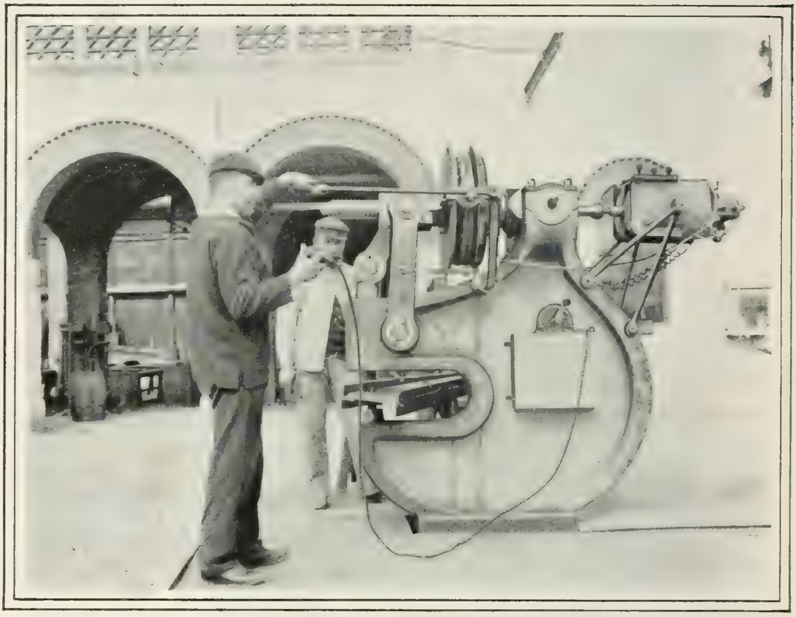
Its construction below the water line must be such that, while it is able to carry the largest quantity of whatever its cargo may be, it must also offer as small resistance as possible in its passage through the element in which it sits. Further, in order that it may be driven through the water at the highest possible speed, its lines must conform to certain principles. It must have something of the build of the fish about it, though the fish must be beaten upon its own ground if possible, and as far as possible. And this leads to the beautiful lines and the graceful curves that are seen in the outlines of all vessels that are intended to travel swiftly through the water, the extreme case of which is seen in the curves of the yachts which have been contesting the supremacy of the yachting world.



LARGE HORIZONTAL BENDING ROLLS, ELECTRIC-DRIVEN, IN THE SHIP-BUILDING YARDS OF THE MARYLAND STEEL COMPANY, SPARROWS POINT, MARYLAND.

The rolls are capable of bending plates up to 30 feet in length.

But all this, while the effects produced are charming, places considerable difficulties in the way of the designer and the constructor. The outline of the ship is made up of curves, varying in every part, and to these curves the steel of which the ship is built have to be worked; and here comes in the use of machinery, the question of the delivery of power to the individual machines, and the question of the use of electricity for the purpose. The lines of a ship near the bows, the curves to which plates, ribs, beams, etc., must be bent, are quite different from those in the neighbourhood of the stern, while both are quite different from the curves amidships.

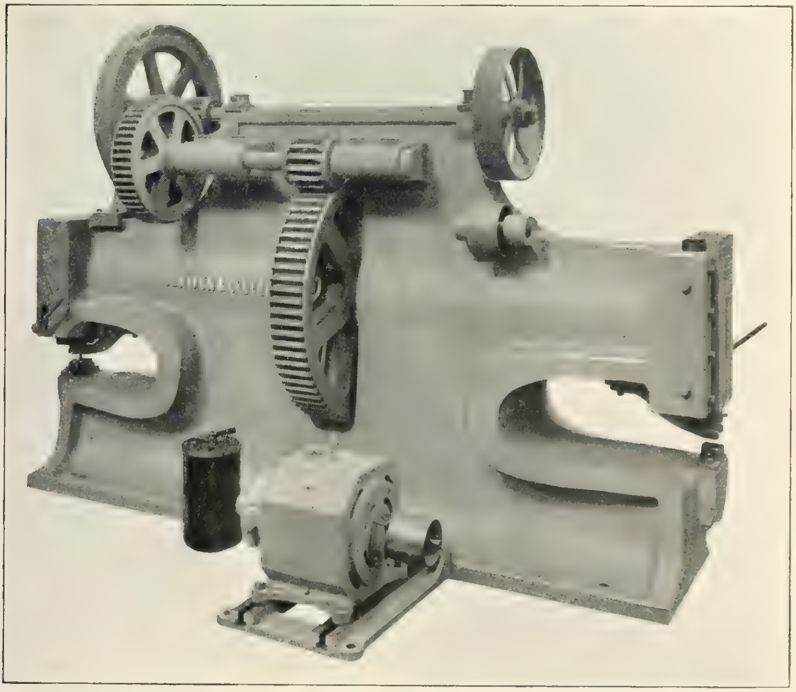


FIXED TYPE ELECTRIC RIVETTER, KODOLITSCH SYSTEM, AT WORK.

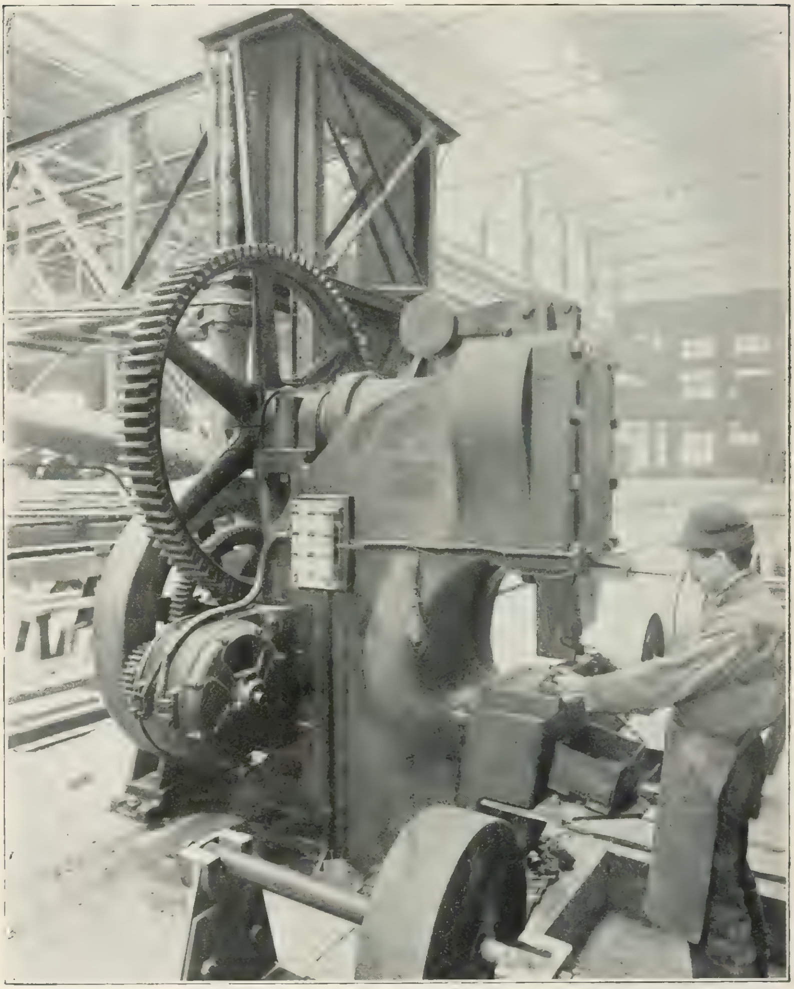
Courtesy of Mr. F. S. Dudgeon.

In the days of the wooden walls of old England, which have now passed away forever, the ship was built up entirely by hand labour. Ribs, beams, keel, keelson, stem, sternpost, outside timbers, all were cut by hand to the proper shape, and put into place by workmen whose great skill had come down to them more or less directly from the Vikings, from whom both Englishmen and Americans claim descent. But with the introduction of iron, and still more with the supersession of iron by steel, hand labour has gradually given way to machines. And as ships have become bigger and parts of ships have also become bigger, the necessity for machinery, ever increasing in size and in the power required to drive it, has become more and more accentuated. Sir William White, in his presidential address to the mechanical section of the British Association for the Advancement of Science, in 1899, mentioned a striking incident which had come under his personal notice, when he was a boy in the Royal dockyard. It was sought at that time to introduce a machine to cut out the ribs of ships that were built for the Navy, but after an extended trial it was given up, as it was found that the men who were accustomed to cut out the frame timbers could beat the machine. Such a thing could not happen now. It is thought that the race has deteriorated, owing to the exodus into the towns since those days, but even the strongest group of the men of those days who could have been collected round a modern plate, 28 feet long and weighing from 2 to 3 tons, could do very little in an economical sense. Prof. Biles, in his exhaustive and interesting series of articles in The Engineering Magazine, has explained the methods of moulding the different parts of a modern ship, and he has explained how each plate and each portion of the frame of the ship has to be handled by successive machines, and passed on from point to point, till it is at last firmly fixed in the position it is to occupy as part of the general structure. There are three portions of the work of building a modern ship, therefore, in which electricity is at present used to a moderate extent, (moderate only in proportion to the whole), and in which it will probably increase in use, while there are also portions of the work to which electricity has not yet been applied, but to which, in my opinion, it is more than probable that it will be applied in the future. The portions of the work in which it is used now are:

1:—Driving individual machine tools for performing the various operations through which the frames and outside plating have to pass.



DOUBLE-ENDED ELECTRIC-DRIVEN PUNCHING MACHINE.
Punches 1¼ inch holes through 1¼ inch steel plates 36 inches from the edge.



ELECTRIC-DRIVEN PUNCHING MACHINE, NEW YORK SHIP-BUILDING COMPANY, CAMDEN. N. J.

2:—Operating tools that are used to complete the work which has been partially performed in the machine shops, these operations taking place upon portions of the structure *in situ.*

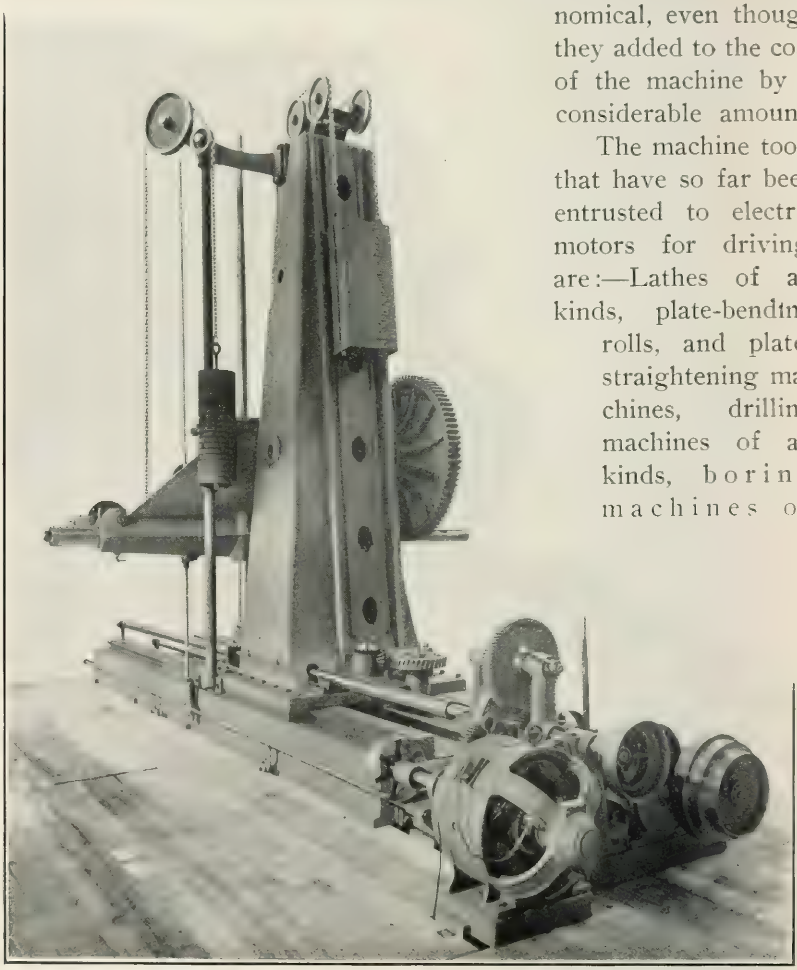
3:—Furnishing the power required for handling the masses of iron and steel that have to be dealt with in the construction of a modern ship.

Steel is received from the steel makers in a form as closely approaching that in which it is to be used by the ship-builder as the steel maker can produce. But in the great majority of cases, as received from the steel maker, even after handling by the latest modern plant at his command, H sections, T sections, angle sections, Z sections, and plates, are still in a more or less crude form, so far as the ship-builder's requirements are concerned. It is necessary for his requirements that the sectional portions of which the frame is built, and upon which the plates are fixed, should be of exactly certain lengths and moulded exactly to certain curves, or the desired contour of the ship when completed will not be attained. Plates, and bars of various sections also, are not always perfectly straight. Handling in the steel works and by the railway companies, or by the ship's companies where water carriage rules, do not add to exactness in these particulars.

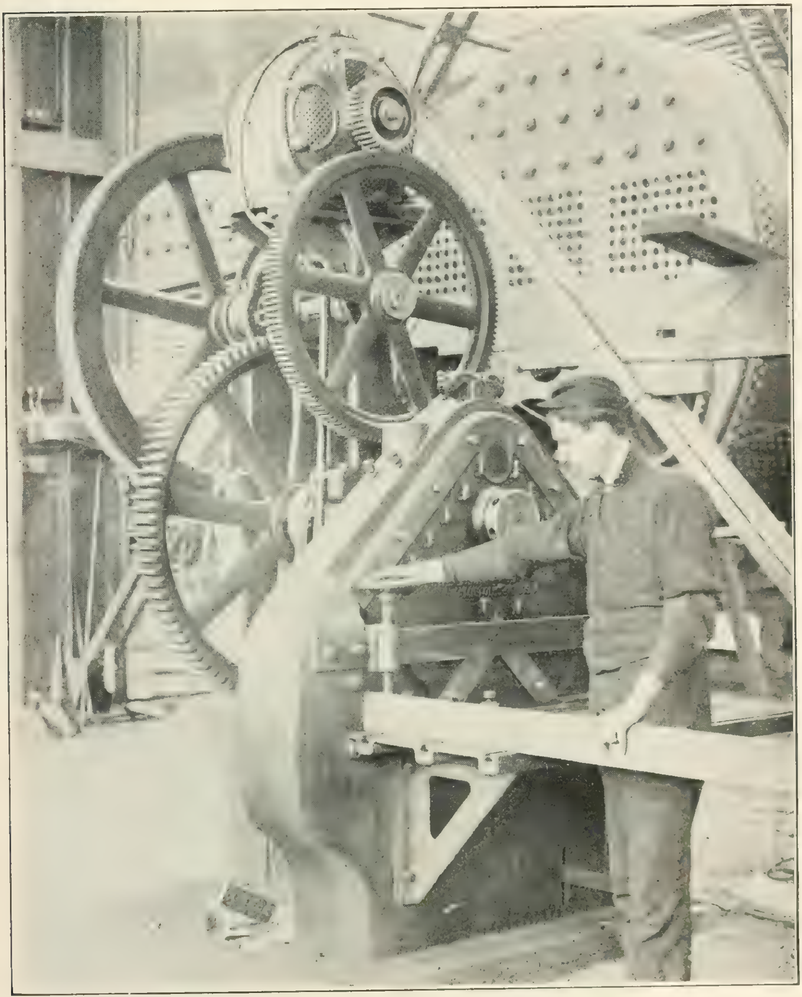
The ship, when built, has to be driven through the water, and has to be provided with engines, boilers, and the numerous accessories that go to ensure economy and speed; and as ships have become larger, and the rate of travelling faster, engines and boilers have all become larger and heavier, so that the machines required for dealing with this part of a ship's equipment have also grown enormously. And so it has come about that a formidable series of powerful machines has come into existence, all seeking to economise labour, both in performing the different operations necessary upon the steel in its various forms, and also in the handling of the masses of steel themselves. Economy has also dictated that, where it is possible, two or more operations shall be performed by one machine, if possible at one setting. Arrangements which enable this to be carried out save considerable amounts in the cost of working the steel into the form of a ship. Thus machines are arranged to drill several holes in boiler, or ship's side plates, at one operation; to bore and turn at one operation, and to bore, turn, and mill at one machine, sometimes with one setting.

Machines are also arranged for straightening plates and sectional steel, for bending plates and sections to the required form, for planing their ends, for turning flanges on their ends, for bevelling, where the structure requires it, for shearing, punching, drilling, countersinking, for cutting the holes in plates for man holes, side-light holes, and similar operations, all of which, in the days of wooden vessels, were done entirely by hand labour. Electric driving is being cautiously applied to all of these machines, though up to the present only a portion of the machine tools in use have been entrusted to the care of electric motors. There is still a fear, on the part of those who are responsible for the turning out of work quickly, that electricity may fail them at the critical moment. Electrical engineers also have not always been wise in their generation. In many cases they have endeavoured to do the work with motors that were too small and would not stand the strains which were brought against them, and in other cases they have failed to grasp the true significance of the flexibility of the electric motor. They have in many cases, until taught better by experience, tried to perform several operations by means of one motor, which could be much better performed by two or three. They have not appreciated the fact that an electric motor can be put into a small space, and can be made to almost any form, and that it uses nothing when it is not working, so that motors arranged for performing some of the operations that were performed by belts in the old days would be economical, even though they added to the cost of the machine by a considerable amount.

The machine tools that have so far been entrusted to electric motors for driving, are:—Lathes of all kinds, plate-bending rolls, and plate-straightening machines, drilling machines of all kinds, boring machines of



HORIZONTAL BORING, DRILLING, AND MILLING MACHINE, DRIVEN BY ELECTRIC MOTOR.
Niles Tool Works Company.

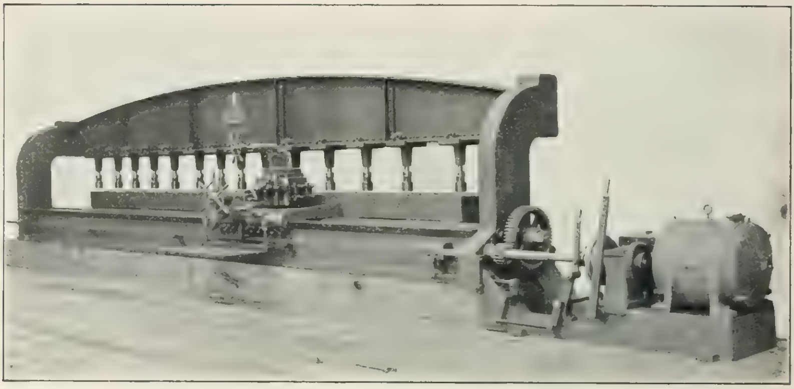


ELECTRIC-DRIVEN SHEARING OR CUTTING-OFF MACHINE, NEW YORK SHIP-BUILDING COMPANY'S YARDS.

Long & Allstatter Company, Hamilton, Ohio.

various forms, joggling machines (machines for forming the edges of two steel plates so that they will overlap each other, instead of lying with their edges together, very much after the style of the old clinker building in wooden days), bevelling machines, machines for cutting steel bars or plates to the required length, and others.

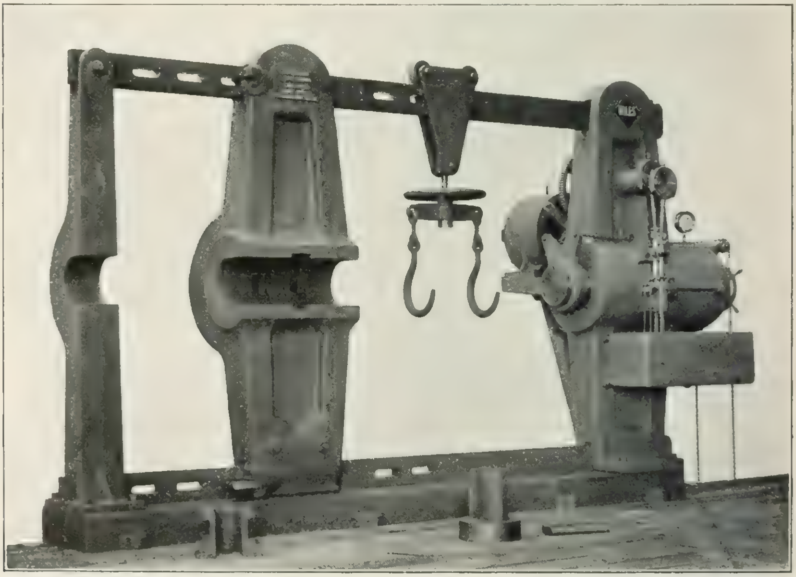
The above machines are all large and intended for heavy work, and the electric motor merely replaces the engine which previously drove the tool; and it goes without saying that this process of substi-



ELECTRIC-DRIVEN PLATE-PLANING MACHINE TO TAKE PLATES 25 FEET LONG BY 2 INCHES THICK.

Niles Tool Works Company.

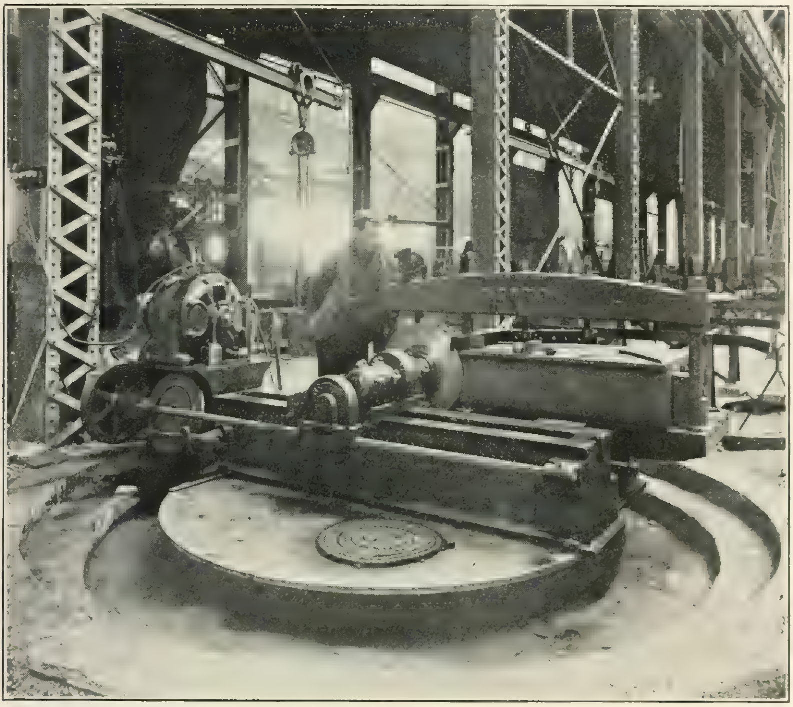
tution of electric motors for steam engines, where the latter have been used for driving machine tools can go on as far as ship-builders wish. The substitution, provided it is carried out in a proper manner, can mean only economy and convenience. The absence of steam pipes in the immediate neighbourhood of machine tools is in itself a great boon, leading to cheaper and better work and to absence of breakdowns.



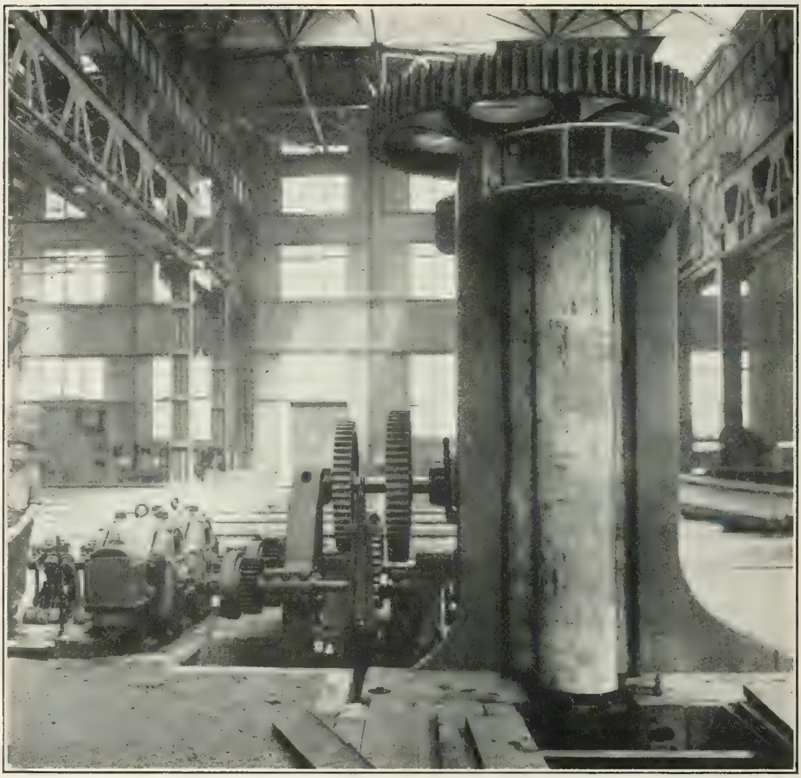
SPECIAL HYDROSTATIC WHEEL PRESS, THE PUMP SUPPLYING THE RAM BEING DRIVEN BY AN ELECTRIC MOTOR.

A modification is used for securing cranks on their shafts. Niles Tool Works Company.

But in addition to the heavy machine tools which demand their own motor, because they have had their own steam engine, ship-building yards are also applying electric motors very largely to driving groups of machines of smaller size, the individual machines taking their power from a line of shafting. This is merely a transition stage, so far as a large number of machine tools is concerned. It usually happens in every industry—and ship-building is no exception—that it is difficult to get managers to spend money on new plant except under pressure of orders. Then this is the complaint of the electrical engineers who have done a lot of this kind of work—when the change is made, it must be done in such a manner as least to interfere with the running of the works. Hence it happens that in place of splitting up the driving from a line of shafting, the shafting and its belts are left in their place, and merely the shaft itself is driven by an electric motor, instead of by a steam engine or from some other shaft. Economy is realised in this manner, but not to the extent that it will be later on. In any machine shop, the absence of belts and of the necessity for having all



ELECTRIC-DRIVEN COLD SAW, NEW YORK SHIP-BUILDING COMPANY'S YARDS.
Newton Machine Tool Company's tool driven by Westinghouse motor.



HEAVY VERTICAL STRAIGHTENING OR BENDING ROLLS DRIVEN BY WESTINGHOUSE ELECTRIC MOTORS.

New York Ship-Building Company, Camden, N. J.

machines in one line is a great advantage. Absence of belts enables the whole of the machine shop to be swept by an overhead crane without inconvenience, and the absence of the necessity for having all machines exactly in one line practically increases the space at the disposal of the works manager. He can fit machines according to convenience. There is a limit below which it is not wise to multiply motors in electric driving, and this limit will vary with each individual works; but it may safely be stated that, except in special case, machines taking more than 4 horse power to drive will pay for separate motors, while there are cases where it pays even to divide up considerably more than this. Groups of machines turning out the same parts may usually be driven together, but the division in these cases should be such that the stoppage of one motor does not stop the works for the want of the particular parts.

MONEY-MAKING MANAGEMENT FOR WORKSHOP AND FACTORY.

By Charles U. Carpenter.

I. A RATIONAL AND ECONOMICAL SYSTEM FOR CONTROLLING FACTORY DETAIL.

The importance of Mr. Carpenter's subject needs no argument; the title is all sufficient. It is the problem which faces every manager—to carry on his works not only to mechanical success but to practical, financial prosperity. Mr. Carpenter writes from experience in an enterprise which stands as a model of business success, of excellence in mechanical quality of its output, and of enlightened methods of labour handling. He deals with actual working methods tested by the severest conditions of daily shop use. He gives proved solutions of the concrete, physical problems of organising the factory and handling the processes of manufacture with the greatest economy, certainty, smoothness of operation, and clearness of record. His articles will be practical shop papers by a practical shop supervisor. The next article will take up a concrete working example of the system outlined below; following numbers in the series will treat of the receipt and issue of stock, machining, tools, inspection, assembling, scrappage, inventions, piece work, and costs.—The Editors.

ORGANIZATION is the most potent force in the commercial world to-day. Its true principles will develop a power well-nigh illimitable when intelligently and properly applied to any form of business. Many firms now recognize the fact that very large economies can be effected by the introduction of rational and efficient factory systems which will properly care for the highly important details of factory work. Few are they, however, who fully realize how great might be the increase in the efficiency of their organization, and how large the consequent economies, did they but possess a system of factory organization and management founded upon principles which tend to develop at least an approximation to that ideal condition where every man—workman, foreman, and superintendent—is constantly working toward one common end—"The good of the company."

The question of the proper formation of such an organization is of vastly greater importance than the perfection of details of factory systems, great though this latter may be as a factor in the success of a business. If the system of organization is founded upon the correct principles, the perfection of the details will follow as a natural sequence.

One can but admire the wonderful systems of organization and management by which the present enormous business interests of the United States are governed. In this will be found one of the chief reasons why American corporations will live and excel in the business world. It is of great interest to note that the system of organization and management advocated in this paper has been developed along the same lines as those followed by these large concerns. In this case, however, the same principles are worked out in much greater detail and are put into effect in the management of the factory and working force. The results are as admirable and profitable in the mill or factory end of the business as they have proven to be in the organization of the executive branches. The great power of these immense business interests will be but partially developed so long as these ideas are not applied to their fullest extent to the executive, recording, and working forces alike.

Many a firm is today staggering under a load imposed upon it by bad and inefficient systems, both of management and of details of factory work. Some will not awaken to a full realization of the situation until some finely organized competitor drives them to the point where an investigation of "what is wrong" is absolutely necessary. Many a manager is asking himself the question: "How and why is it that our competitor, who is working under practically the same conditions that we are, can undersell us and still make a profit?"

Even where competition is not serious the live manufacturer has an uncomfortable and often justifiable feeling that he is neither securing the results from his system of management that he desires, nor making the profits from his products that conditions warrant him to expect. A number of questions press him for answers. Is his entire force working together in hearty co-operation with the management? Is his system of management capable of maintaining its growth and efficiency with the expansion of the business? Are his factory systems such that the very best results are being obtained? Is the output as large and the quality up to as high a standard as his expenditure warrants him to expect? Are his workmen giving him a full day's work? Is his piece-work system thoroughly reliable, and does it extend over as large a percentage of the work as possible? Is the inspection of parts thorough and inexpensive? Is his stock-tracing system sufficiently effective to prevent altogether vexatious and expensive delays? Does he know what stock is scrapped and why? Are his costs accurately compiled and calculated? Are all of the parts produced in the cheapest manner, and in such a way as to make them interchangeable?

Under the ordinary systems it is impossible for men to come in close enough contact with all the enormous amount of detail incident to any large business, to enable them to possess that knowledge of factory efficiency that is so absolutely necessary to obtain the best results. The business has, in many cases, grown to such an extent that the old systems which proved fairly satisfactory when the business was smaller and personal attention could be given to important details, are altogether inadequate to meet all the conditions arising with the growth of the business.

With this growth, the development of a system of factory management that will bring forth the latent efficiency of the organization, and also of simple and inexpensive factory systems that will enable the management to keep in close touch with the work in the factory, and give to the manager or superintendent the very necessary assurance that the work in all its details is being carried out in the most efficient manner possible, will prove invaluable. These results can be accomplished only by the adoption of up-to-date methods of organization. The large savings and increased efficiency resulting from the introduction of such systems have been absolutely demonstrated, when the particular conditions of the business were studied and systems introduced by those whose experience fitted them for this important task.

It is certainly not my claim that any system, or series of systems, will in itself prove a "cure-all" for defective factory management. The disposition and ability of the men upon whom devolve the duty of putting the systems into effect must always be taken into consideration. Their co-operation must be secured before the success of any attempt to reorganize the working force is assured. Unless these men are taken into the confidence of the management, unless they are convinced that any proposed change will prove of material benefit to them and the organization, they will oppose any attempted improvement and it will inevitably be deprived of its most beneficial features.

In this paper will be presented a number of ideas on the subject, which, upon development, will prove their efficiency in enlisting the sympathy and hearty support of the superintendent, foreman, and assistants in the work of the company, and in developing an organization, strong, flexible, capable of expansion, and having in it those fundamental principles which, when developed, will result in as near an approach to our conception of a perfect organization as we may ever expect to secure.

Defects of Organization:—The defects of factory organization can be grouped into two general classes:—First, the narrow and defective methods by which the factory organization has been developed; second, the lack of broad and efficient factory systems by which the work can be done in the best and cheapest manner possible and the management kept closely informed as to the important details of the factory work. We will first take up a few of the most serious faults that exist under the ordinary system of organization and management.

Superintendent and Assistants:—In very many cases the superintendent is loaded down with detail work that either he or the management considers he should attend to. This is often carried to such an extreme that he cannot give his attention to the larger and broader problems for which his education, experience, and ability fit him. His assistants are often not given sufficient authority, or they are men who are not strong enough to be trusted with responsibility. There is lacking in many cases that feeling of co-operation between these men which is such a strong factor in an efficient organization. At times we can even find a man who has the idea that his own position is strengthened by not having strong assistants, and by keeping all the important details of the work in his own head. Repeating the trite saying of a prominent manufacturer: "The bane of factory organization is he who keeps all important and necessary information under his hat, whether he be workman, foreman, or superintendent." The result is that very often when the man and the hat go out the front door, the desired information goes too and the efficiency of the organization is seriously impaired until the problems can be taken up and solved by others.

Lack of Discussions:—The most serious mistake in most organizations is the fact that consultations with foremen and assistants are held so seldom, and even when they are held, are confined to so few men. It is a fact that in very many cases no attempt is made to secure the great benefit that would be derived from obtaining the advice of many men of wide experience on subjects of the greatest importance to the organization. This defect must be remedied if the concern expects to get the best possible results from any system of management. A firm is adopting a very short-sighted business policy when it refuses to acknowledge the fact that decisions based upon the free discussion and deliberation of men of experience, are wiser, stronger, and much more effective than those of any one man. Serious consideration on the part of most business men will show them that serious and costly mistakes could have been avoided if they had but availed themselves of the information possessed by all the experienced men in their establishment. The remedy for such conditions is as simple as it is effective and is the foundation upon which are built some of the most successful organizations of the present day.

Foremen:—There are a number of questions that usually confront an organization and its superintendent in regard to their foremen. There is often a lack of a proper degree of co-operation on the part of these men with each other and with the officials of the company. There exists a certain degree of jealousy of each other's acts and attainments which impairs the efficiency of the organization. There is often a lack of frankness on the part of the foreman in regard to their own mistakes. They do not give the workmen the proper encouragement to offer suggestions in the line of improvements, and they do not make improvements themselves.

Workmen:—The question of the proper handling of the workmen in order to secure the best results is one that is entirely too large to be discussed in this paper. This problem is still far from being solved It is not hard to recognize the many difficulties of the situation, but it would be an altogether impossible task to set down any rules that would prove at all general in their efficacy. If space permitted, it would be profitable to study why the workers lack interest in their work; why they shirk and produce work below the standard, and why the suggestions for improvements are so few in number. However, a description of methods will be given by which the interest of a majority of the men can be vastly increased and a great gain effected in the general efficiency of the working body. To effect an improvement in an organization of a body of workmen, the methods adopted must be of such a nature that the men will find it is to their personal advantage to show their skill and facility in handling work, and feel certain that they will receive full credit for any suggested improvements. The methods must prove to them that they are considered a part of the organization, and that, if they but prove their ability, they will be recognized and advanced as opportunties offer. One of the worst features of the systems usually in force lies in the fact that the larger the organization grows, the weaker and more inefficient it becomes. It is a fact that the systems generally in use fail utterly to care properly for the important details of the business as it expands beyond the limits bounding it when they were installed.

Requirements for Good Organization:—In an organization constructed on the strongest and most efficient basis, the head must be supported by strong subordinates. These subordinates must have the necessary ability to care properly for a large portion of the detail work that is so often forced upon the attention of the head.

Discussions:—The most important principle which can enter into the plan of any organization is the free discussion of important subjects by all who are competent for this important work. The benefits to be derived from such methods cannot be over-estimated. Not only does the organization get the direct benefit of decisions which are based upon the full consideration of the subject under discussion by men of wide experience, but it also receives the indirect but great good coming from the inevitable growth of interest on the part of the men in the affairs of their employers. Those concerned in these discussions must necessarily be greatly benefited by coming in such intimate contact with other men of equal capabilities. In fact, such a system tends to lift the entire body of men up to a higher plane. Again, it imparts great strength to the organization, inasmuch as information necessary to the welfare of the business is thus possessed by a number of men. It cannot be weakened by the loss of important men. The granting of this degree of responsibility to a number of men makes all others feel that there are greater opportunities for advancement, the consequences of which will be far-reaching.

In place of putting all the responsibility upon one pair of shoulders and depending upon the judgment of one man for the consideration of important questions that come up for settlement, the burden should be carried by a number of the best-informed and best-balanced men in the organization formed into boards, or committees, with power to act. Promotions whenever and wherever possible should be the rule. Every man from superintendent to workman should understand that ample opportunity will be given him to prove his worth and that no one can withhold this from him.

Suggestions and Complaints:—The greatest encouragement should be given to everyone to make suggestions and complaints. This is a most important question for any concern. Experience has shown that not only will these suggestions and complaints be a source of great profit to the company, but the effect on the men will be very beneficial to the entire organization. The recognition of their efforts will prove a great spur to them and to others, and not only will their interest in the organization be increased, but the augmented attention given to their work will invariably result in a better and cheaper product.

The organization should be capable of indefinite expansion, keeping pace with the growth of the business without becoming weaker or less efficient in any way. Its strong brainy men should be automatically and irresistibly developed. It should have the capacity to respond to a sudden call for extra effort. Serious errors should be reduced to a minimum. There should be fostered and developed a strong spirit of co-operation and desire to take advantage of every opportunity to effect improvements and economies.

System Proposed:—To bring about these desirable results, I propose a system of organization that is built up and developed along lines that are diametrically opposite to the usual methods. It is in practice today, and has been for a number of years, under the most difficult conditions possible, and the results themselves provide sufficient proof of the fact that it is an unqualified success. The methods can be adapted with equal success to steel mills, manufacturing establishments, and, in fact, to any line of business.

Board of Supervisors:—In place of a superintendent and assistants there must be a governing board of supervisors. This must not be so large as to be unwieldy, five men in most cases meeting all the requirements. This board must be the supreme and final power in the factory, the only official in the organization ranking it in authority being the general manager. All important matters must be settled by this board after full discussions and a frank and fair expression of opinion on the part of each supervisor. All general complaints and suggestions should be handled by it.

One of the matters of greatest importance would be the close consideration of inventions, new designs, or new products of any nature. These should first be submitted to this board. Should they decide that it would be practical to build or produce the article, it should then be submitted to all individuals who by their experience and ability are fitted to pass judgment upon it, for consideration and thorough tests. All of these should submit complete written reports of their test together with any criticism or suggestion they might have to offer. Experience has shown that such methods will demonstrate the existence of defects and possibilities of improvements never suspected by the originator of the idea. Absolute rules must be made that under no circumstances will a new product be put forth which has not received a full and thorough test and the order and sanction of this board. Regarding the system from this standpoint alone, it is above criticism. Such methods will almost preclude the possibility of costly errors of judgment in placing upon the market products of defective design or workmanship.

This board should have a permanent chairman selected by the company, and all orders emanating from it should be issued in his name.

The chairman of this board should be the person highest in authority in the factory. Meetings of this board should be held at least four times per week and attendance at these meetings must be compulsory.

Duties of Members of Board:—Each member of this board should have certain departments allotted to him according to his particular ability and experience, over which departments his authority should be complete. Personal authority, responsibility, and the power to make quick decisions will not be interfered with in the least by this system if it be properly applied. In fact, it will tend to foster and develop all of these under proper conditions. The fact that all important matters must be brought before the board will force prompt settlement. Those in authority can be granted ample power to settle matters demanding immediate attention. Any important actions so taken, however, should at once be reported to the board.

Sub-Committees:—In most establishments the product handled is of a varied character, be it machines, steel, or what-not, and each type of product will have its own peculiarities and defects. All suggestions, improvements, or complaints relating to these products should receive the consideration of the most competent men in the organization.

These questions should not be handled by the board of supervisors alone: first, because they should not lose the benefit of the wide exrience of their foremen in the factory who are most familiar with this and other lines of work; second, because we must never lose sight of the fact that from bottom to top there must be a steady development and selection of the strong and forceful men and the opportunities to bring these men forward must not be lost. It is necessary, therefore, to form a number of sub-committees to handle these questions properly.

These sub-committees should have as members the board of supervisors and the heads of departments who have the most intimate knowledge of these particular products. Other heads of departments should often be called into consultation in order to secure all possible benefit from their knowledge and experience. Each sub-committee should have as its chairman one of the board of supervisors.

The work of these sub-committees will be of the greatest importance. All improvements, suggestions, and complaints, referring to matters that properly come under the supervision of the sub-committees, must be considered by them and action taken in all cases. Changes in tools or in processes of manufacture should be absolutely prohibited without the sanction of the proper committee having this supervision, or in urgent cases, of the chairman. In the latter case such action should be reported to the committee later. Adherence to this rule will result in freedom from error, order, and a thorough understanding among those concerned, in place of costly mistakes and endless confusion. These committees should also consider any proposed changes in the product, or any invention relating to it. Reports of all inventions should be sent by them to the board of supervisors. Striking economies will naturally result from the discussions that will arise in these bodies. Experience has proven that the members will soon understand that their reputations are at stake in making decisions and their opinions will be singularly fair and free from personal bias.

The board of supervisors should have the authority to overrule any decision of the sub-committees, should it be deemed advisable.

Meetings with Foremen:—The supervisors should frequently hold meetings with their foremen in order to consider questions of interest to all, or to suggest economies that might be effected by all working in concert. By this system each member of the board will have the most intimate knowledge of affairs, not only in the departments under his own jurisdiction, but also in the entire factory.

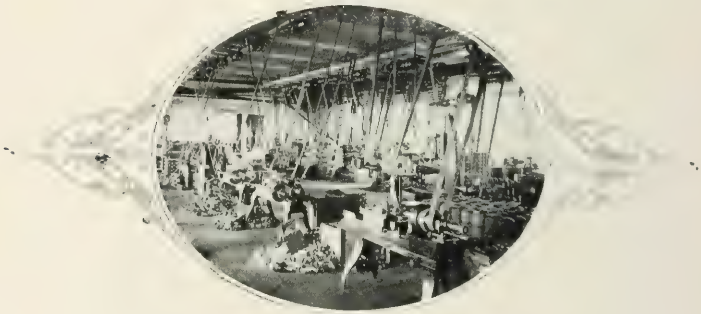
General Committees:—This system of forming committees should be extended to the office departments and executive forces. The underlying principles will be the same, and the result of their application in these other co-ordinate branches of the business will prove equally effective. The firm gains by the many satisfactory conclusions reached; it gains by the development of the forceful men who will prove a tower of strength to the organization; and again it gains by inspiring all the heads of departments with the definite assurance that the man of brains will be noticed and advanced.

All committees should have an appointed time for meetings which must not be deviated from, the presence of all members being insisted upon.

General Meetings:—Meetings should be held at least once a month of the board of supervisors, heads of sales departments, and the officers of the firm, to consider prospects for new business, needs of the market in the way of new product, needs of the factory, records of output, costs, sales, and reports in general, which should naturally be submitted to the higher officials of the firm. There should also be instituted a general meeting of all supervisors and the heads and assistant heads of departments once every three weeks, where all matters of general interest to the organization should be freely discussed. In these meetings each head of department should be prepared to make a statement as to the condition of his department and make whatever complaints he may deem worthy of consideration. It is very important to pay close heed to this latter point in order to gain all possible benefit from these meetings. The men should thoroughly understand that just complaints, which will lead to the correction of any faults, are honestly desired. Delays and mistakes occurring in the different departments should also be brought before these meetings for consideration and explanation. If a number of different departments are involved this is the safest and best way to get at the bottom of any difficulty and correct it.

Such meetings tend to develop men still further. They become better acquainted with each other and with the officers. The jealousy that usually exists gives way to a clearer appreciation of each other's difficulties. There will often appear in its stead an earnest desire to help each other and an appreciation of the fact that their endeavors should be centered solely on doing that which will benefit the organization. They cannot but take greater interest in their work, as they will naturally feel that they are an integral part of the organization.

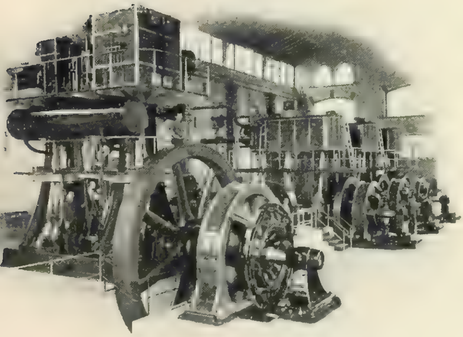
In the outline preceding has been given the framework of an organization which may seem to many managers a radical and dangerous departure from accepted ideas. The demonstration of its practical soundness can best be made from a working example, and the next paper in this series will take up a concrete instance of the adoption of this system for the distinct purpose of securing a stable, potent, and economical establishment for mechanical production.



ENGLISH, AMERICAN, AND CONTINENTAL STEAM ENGINEERING.

By Philip Dawson.

Mr. Dawson's articles began in THE ENGINEERING MAGAZINE for November, 1901. Of the three preceding papers, the first two discussed British steam engineering and traction plants, and the third Continental steam practice. The article following completes the present series. Next month we shall begin a most instructive and interesting series by Walter M. McFarland, late chief engineer U. S. N., on the Growth of Economy in Marine Steam Engineering. THE EDITORS.

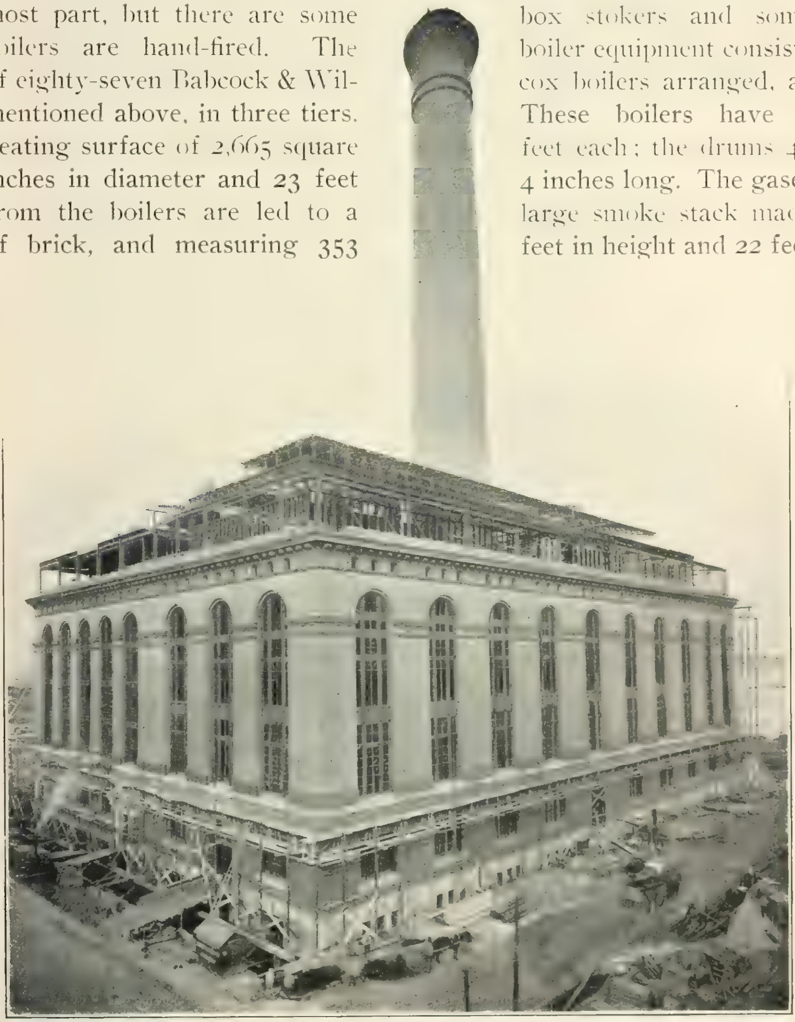


AMERICAN steam-engine power-house practice—the only division of our subject remaining for review—may properly be taken up from the point of the introduction of the Corliss valve. Probably the most important development in steam engineering since the days of James Watt was made by Joe Corliss in 1849, when he introduced his now so famous drop cut-off valve gear. The main features of this gear were the rapid and wide opening of the steam ports, the shortness and directness of these ports (which reduced the clearance to as little as 2½ per cent. of volume in the high-pressure and 4 per cent. in the low-pressure cylinder), the quickness of closure of the steam valves, and the adaptation of the main valve to the functions of a cut-off valve. This type is eminently a slow-revolution engine—for small sizes, not above 250 kilowatts, reaching as many as 135 revolutions per minute, for 800 kilowatts as much as 100 revolutions, for sizes up to 1,000 kilowatts running as high as 90 revolutions, and for larger sizes not above 75 revolutions per minute.

In the early days of dynamo construction up till, we may say, ten years ago, generators were small, a machine of 500 kilowatts being considered enormous, whereas now generators of as much as 5,000 kilowatts are being installed to run the Manhattan Elevated Railway at New York. The smaller dynamos of earlier days were all bi-polar, running a very large number of revolutions, certainly above 200, per minute. Accidents to the electrical portions were frequent when it was customary, as it was in large installations, to drive two or more dynamos off one engine; and indeed in traction stations the use of a countershaft which enabled any steam engine to drive any set of dynamos was nearly universal.

As dynamo construction improved, engineers rapidly perceived the advantages to be gained by doing away with belts and ropes and by coupling the steam engine direct to the dynamo. America developed for this purpose a special type of high-speed engine, the first successful type of which was the Porter-Allen engine and the peculiarity of which was what is known as the flywheel type of governor. The first engines of this form were shown at the Philadelphia Exhibition in 1876. In this form of governor, weights revolving round the shaft in a vertical plane automatically vary the travel of the valve and cut-off by turning the eccentric round on the shaft. Then followed a host of inventors and of new types of engines such as the Armington & Sims, the Buckeye, the McIntosh & Seymour, the Ball, the Ide, the Westinghouse, and many others. With this type of engine, however, the steam economies obtained with the Corliss type of valve gear could not be rivalled. As dynamos grew in size and in economy and efficiency, and especially with the introduction of electric traction and power transmission, which necessitated dynamos running in many cases at an average load equal to 75 per cent. of their rated capacity, the question of steam-engine and consequent fuel economy became of the greatest importance. This necessity had been grasped much earlier by Germany than by the United States, and in 1888 Corliss engines direct-coupled to Siemens generators were already being run to light Berlin. The first use on any scale of such direct-connected units was at the World's Fair in Chicago, in 1893, where a 1,500-kilowatt generator was mounted directly on the shaft of a horizontal cross-compound Allis engine running at 75 revolutions per minute. Then followed directly the plants installed under F. S. Pearson for the Brooklyn stations, and the replacing of the belted by direct-driven setts on the West End Street Railway of Boston. Vertical engines, till within quite recent time, were far rarer in the United States than either in England or on the Continent. It would seem in the light of recent experience that for properly designed engines, certainly for sizes of 1,000 kilowatts and over, vertical engines should always be employed. The wear on the cylinder is reduced, as also the quantity of oil required, and with an automatic oiling system and a well-laid-out station the supervision of such engines will not be greater than would be the case with horizontal ones. America now possesses a large number of stations in which vertical engines are running. No better example of such a station can probably be found than the 96th Street station of the Metropolitan Street Railway of New York.

The boiler house of this station contains three tiers of boilers, and above them, two large coal pockets or bins, each having a capacity of 5,000 tons. From these the coal is led to the boiler furnaces by chutes. The boilers are fired by mechanical stokers of the Vickars type for the most part, but there are some box stokers and some boilers are hand-fired. The boiler equipment consists of eighty-seven Babcock & Wilcox boilers arranged, as mentioned above, in three tiers. These boilers have a heating surface of 2,665 square feet each; the drums 42 inches in diameter and 23 feet 4 inches long. The gases from the boilers are led to a large smoke stack made of brick, and measuring 353 feet in height and 22 feet

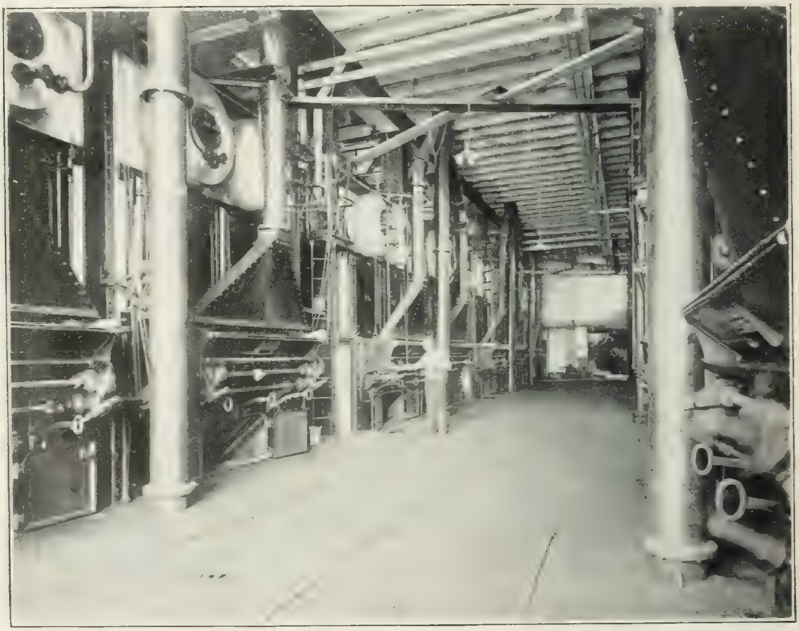


THE 96TH STREET POWER STATION, METROPOLITAN STREET RAILWAY COMPANY, NEW YORK.

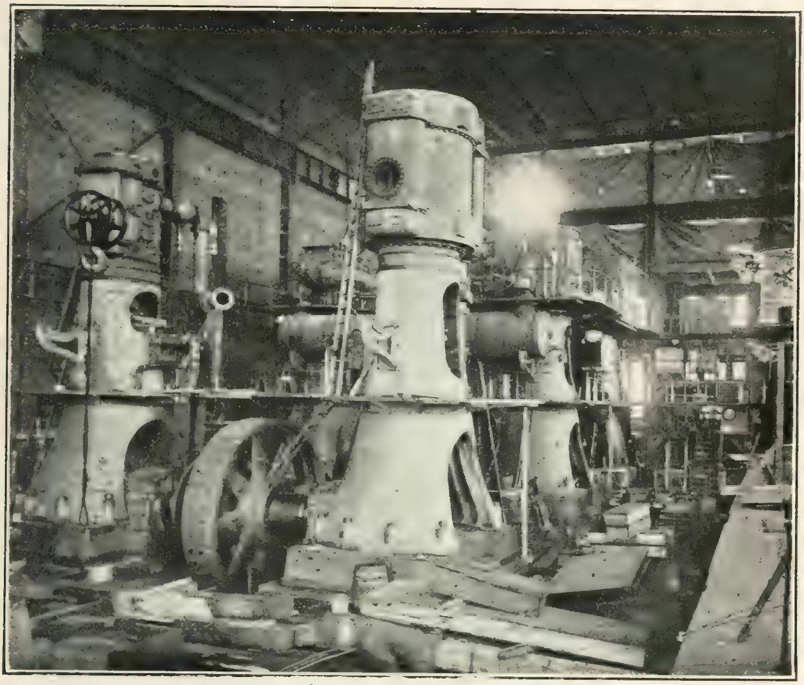
The illustrations of the station are by the courtesy of M. G. Starrett, Chief Engineer.

internal diameter throughout. The condensing plant consists of Worthington surface condensers and independent combined air and circulating pumps, each engine having its own condenser.

There are eleven engines, made by the Allis-Chalmers Co., of Milwaukee, each direct-coupled to one generator. These engines are of the vertical cross-compound condensing type, with the generator mounted on the shaft between the cylinders. Normally the engines give 4,500 indicated horse power when running at 75 revolutions per minute, with steam at 160 pounds per square inch; but they are capable of running continuously at 6,000 indicated horse power or for short periods at 7,000 indicated horse power. The cylinders measure 46 inches and 86 inches in diameter by 60 inches stroke. The shaft measures 34 inches at the journals, 30 inches at the cranks, and 37 inches where the generator and flywheel come; it is 27 feet 4 inches long, and has a 16-inch-diameter hole through its length. The connecting rods are 13 feet 8 inches between the centres. Both the cross-head and crank pins measure 14 inches diameter by 14 inches long. The flywheel is 28 feet in diameter and weighs 150 tons. The total weight of the engine and generator is 700 tons. The cylinders are not steam-jacketted; a reheating receiver is interposed between the high- and low-pressure cylinders.



BOILER ROOM, 96TH STREET POWER STATION, METROPOLITAN STREET RAILWAY.



PARTLY COMPLETED POWER STATION OF THE METROPOLITAN STREET RAILWAY COMPANY, NEW YORK.

The following details of the weights of the various portions of these engines may be of interest:—

Name of Piece.	No. of Piece.	Weight in lb.
Wheel centre, small half	1	21,000
" " large "	1	29,000
Segments of wheel (11 segments)	11	12,000
Lower frame	11	21,000
Slide section of frame	2	36,000
Bed-plate, large half	2	59,000
" small half	2	24,000
Low-pressure cylinder	1	28,000
High " "	1	15,000
Low-pressure-cylinder heads	2	26,000
High " " "	2	7,500
Shaft	1	72,000
Cranks, each	2	23,000
Connecting rods	2	9,000
Receiver	1	20,000

The steam piping is of wrought iron with steel flanges rivetted on; Van Stone joints are used. The drum of each boiler is connected to a 16-inch ring main by an 8-inch header; there are six of these rings in all, two for each tier of boilers. The rings are interconnected by eleven vertical 16-inch mains, which pass into the engine room and lead to the engines, one main supplying each engine. The exhaust piping is of cast iron and is supported by hangers.

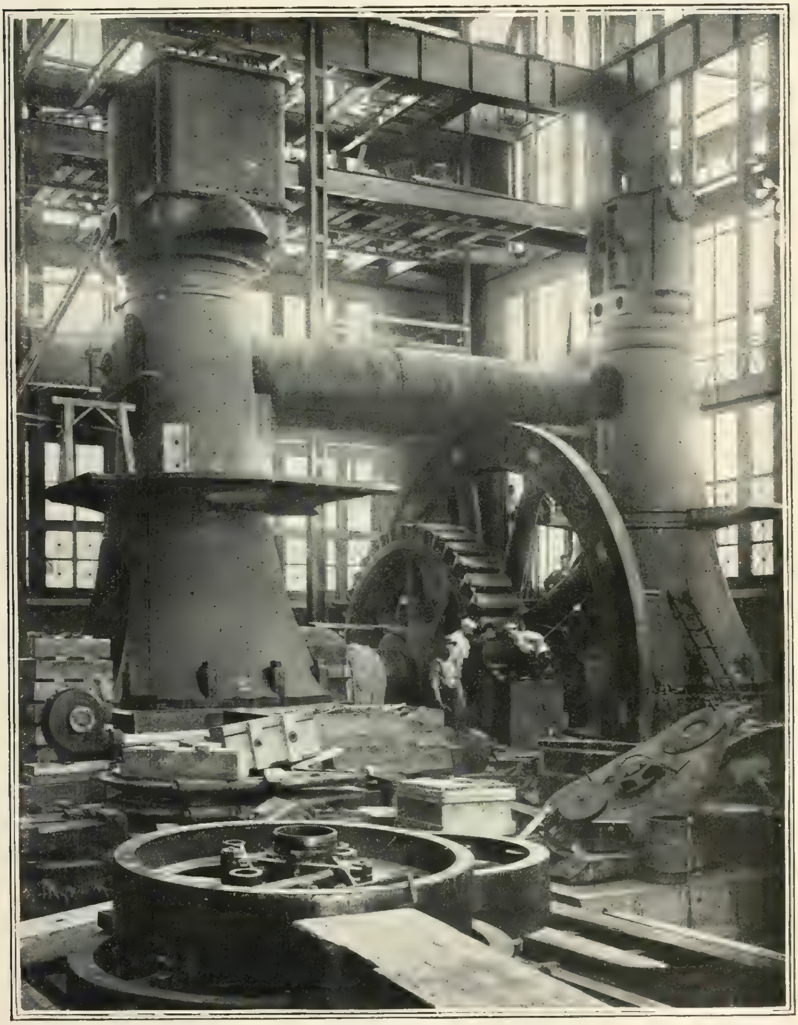
In comparing this station as a whole with similar installations in Great Britain and on the Continent, say with the Glasgow Corporation Tramways or Liverpool stations, or with the Berlin or Hamburg plants, it cannot be said that, taken as a whole, the comparison is entirely favourable to the 96th Street plant. The individual items, such as engines, boilers, steam piping, dynamos, switchboards, transformers, are beyond criticism; but the putting together seems in many instances to have been not as carefully thought and drawn out beforehand as is generally the case with a European plant. No pipe, however small,—no individual wire—is put into a European installation without a drawing being got out beforehand. Great trouble is constantly being experienced with American goods owing to the drawings, which the makers have supplied and which have been approved by the customer, differing widely from the real article when it comes over. It seems impossible to convince the American that, no matter how small the detail, it has been carefully laid out on the plans before construction commences, and that a difference in the goods he supplies from the drawings approved will throw out the whole system. Indeed in some cases, particularly on the Continent, working drawings have to be approved by the police authorities and the slightest deviation from them may entail the throwing out of the whole plant.

It is undoubtedly a fact that as regards finish, the European stations are far ahead of America. It is, however, also true that where, as is the case in Glasgow and Central London stations, European methods of installing American apparatus have been used, the finest results have been obtained.

The largest power plant in the world is now being installed at New York to drive the Manhattan Elevated Railway electrically, and a few details regarding this interesting railway are here given.

Steam is generated in sixty-four Babcock & Wilcox horizontal water-tube boilers, arranged in batteries of two boilers each; they are fitted with Roney mechanical stokers. The furnace gases pass through Green's economisers on their way to the chimney stacks, one economiser being provided for every two batteries. There are four brick stacks, each 278 feet high and 17 feet inside diameter. Forced draught is furnished by sixteen blowers installed by the Sturtevant Co., but the stacks are of sufficient dimensions to furnish the required draft under ordinary circumstances.

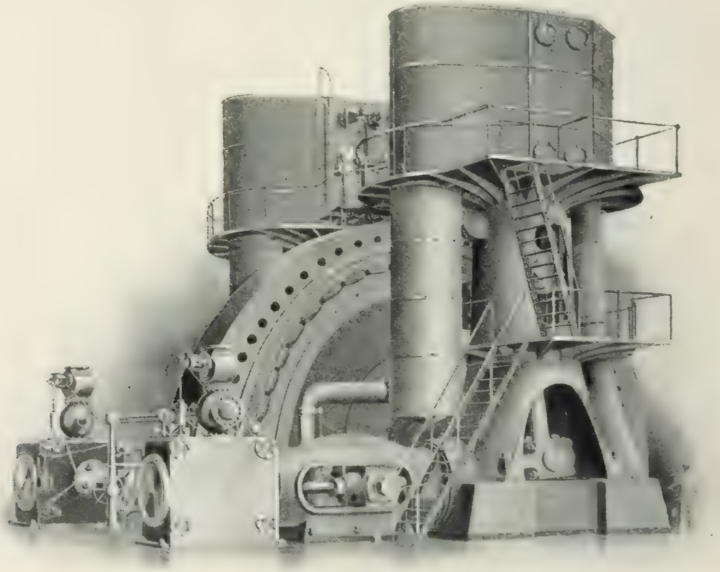
The steam piping is divided up into eight sections, each section



96TH STREET POWER STATION, METROPOLITAN STREET RAILWAY, NEW YORK.
One of the 5,000-horse-power Allis Corliss engines in course of erection.

dealing with four batteries of boilers and one of the main engines. Wrought-iron pipes up to 5 inches in diameter have cast-iron screwed flanges; from 5 inches diameter upwards, the flanges are welded on.

The engines were constructed by the Allis-Chalmers Company, of Milwaukee, and are eight in number. In design they are a radical departure from anything hitherto used in railway power plants. They are four-cylinder combined horizontal and vertical engines, consisting practically of a horizontal cross-compound engine and a vertical cross-compound engine, both working upon the same crank shaft, except that the two vertical cylinders are both low-pressure cylinders and the other two both high-pressure. The cylinders measure 44 and 44 and 88 and 88 inches in diameter by 60 inches stroke. The speed is 75 revolutions per minute. The cranks, of which there are two are set at 135 degrees with each other. The power developed under normal conditions of running is 8,000 indicated horse power per engine. The exhaust steam is dealt with by jet condensers, driven by electrical motors.



COMBINED VERTICAL AND HORIZONTAL ALLIS CORLISS ENGINES FOR THE NEW ELECTRIC EQUIPMENT OF THE MANHATTAN ELEVATED RAILWAY, NEW YORK. ONE OF EIGHT UNITS.

Compare the Berlin tramway power-station engines, page 532, THE ENGINEERING MAGAZINE January, 1902. Each engine is rated at 8,000 horse power for most efficient load, but will operate continuously at 12,000 horse power. Cylinders 44 and 88 by 60.

The Westinghouse Machine Company has recently built and erected some engines at Willesden for the Metropolitan Electric Supply Co., which should be briefly noticed. At these works there are four direct-coupled units, both engines and dynamos being of Westinghouse manufacture.

The engines are 2,500 horse power, vertical cross-compound marine type, with the alternator and exciter armature at the low-pressure end of the crank shaft, and a heavy fly-wheel governor at the other end

The cylinders measure 35 inches and 55 inches in diameter by 36 inches stroke. The crank shaft is 14 inches in diameter. The engine runs at 116 revolutions per minute. The exhaust steam passes into a Wheeler surface condenser, the circulating water being cooled in three Barnard water-cooling towers.

After having reviewed the general practice in Europe and the United States, separately, a few concluding remarks upon the practice of the different countries and comparison thereof is instructive. American engine builders as a rule use larger shafts and main bearings than is usual on the eastern side of the ocean. This is due to the fact that Americans have realised the necessity of flywheel effect, and that the engine and dynamo are built so as to be able to run 25 per cent. overload continuously, and 50 and 75 per cent. overload for short periods without injury. Furthermore, cross-compound engines are largely used with only two bearings—the armature and flywheel, which are next each other, being located between the bearings. The slightest wearing of the bottom shells or sinking of foundation might produce very heavy stresses due to magnetic pull. What these may amount to is shown from the following figures:—

Pull on shaft (from actual practice) due to 1/32 inch displacement of constant-current railway-generator armature.

Kilowatts.	Revs. per min.	Weight of armature in pounds.	Magnetic pull in pounds due to 1/32 in. displacement.
100	250	3,000	3,500
150	225	4,000	5,000
200	180	8,000	7,000
250	100	15,000	10,000
300	160	12,000	8,000
1,500	75	70,000	40,000

The clearance all round between the armature and pole pieces would be about 3/8 inch.

In consequence of marine engines having been built so successfully in Great Britain, when direct-connected generator sets had first to be considered the large shafts and bearing surface asked for were much ridiculed by many engine builders. To a certain extent the same thing obtained on the Continent, owing to storage batteries being nearly universal and heavy overloads necessitating heavy flywheels therefore nearly unknown. It was contended that a marine engine driving a propeller had quite as hard work to fulfil as an engine direct-connected to a railway generator. Three things, however, were overlooked in this comparison.

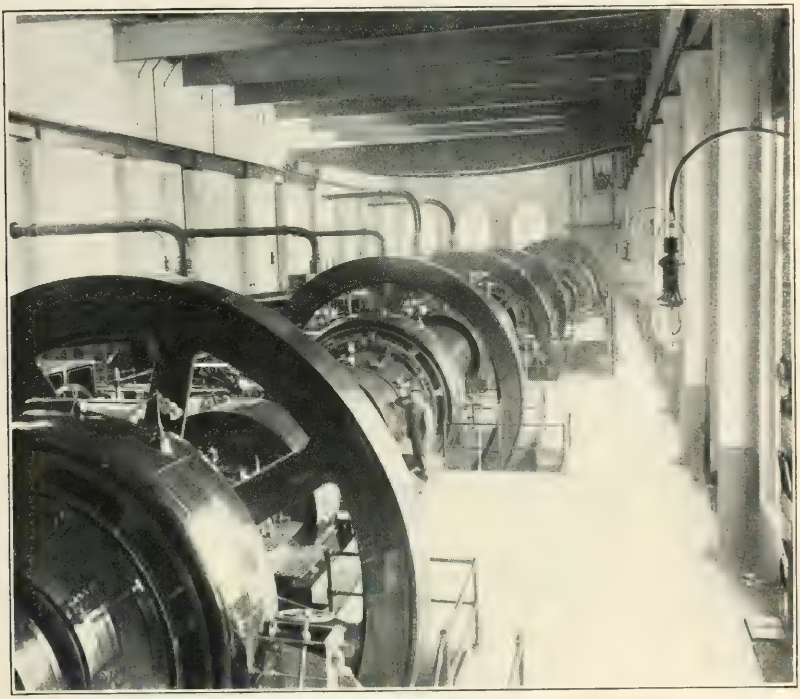
Name of Country.	Station kilowatts available for lighting and power.	Station kilowatts available for traction.	Miles or single track electrically equipped.	Number of motor cars running.	Total electrical station capacity available for all purposes in kilowatts.	Population of Country.	Area of Country in square miles.	Total approximate capital invested in pounds.
Great Britain....	200,000	80,000	900	2,600	280,000	40,000,000	121,115	35,000,000
Germany................	170,000	54,000	2,300	5,400	224,000	53,000,000	211,168	29,000,000
France...	70,000	......	800	1,300	95,000	39,000,000	204,146	12,000,000
Switzerland..............	30,000	7,500	250	330	37,500	3,000,000	15.469	4.500,000
Belgium	15,000	3,000	120	200	18,000	6,600,000	11,373	2,100,000
The whole of Europe.....	400,000	154,000	5,000	9,800	550,000	350,000,000	3,756,970	85,000,000
U. S. A......	1,200,000	800,000	21,000	68,000	2.000,000	70,000,000	3,581,885	600,000,000

SOME COMPARATIVE APPROXIMATE FIGURES OF ELECTRIC LIGHT, POWER, AND TRACTION STATIONS IN EUROPEAN COUNTRIES AND THE UNITED STATES OF AMERICA AT THE PRESENT DAY.

First. A marine engine has a maximum load but cannot ever be instantaneously overloaded as much as 100 per cent., as often happens in traction work.

Second. The shaft, and consequently the bearings, have not to carry a heavy flywheel and armature.

Third. An immense extra stress can be exerted on the shaft should the armature get out of centre.



SOUTH SIDE ELEVATED RAILWAY, CHICAGO, POWER STATION.

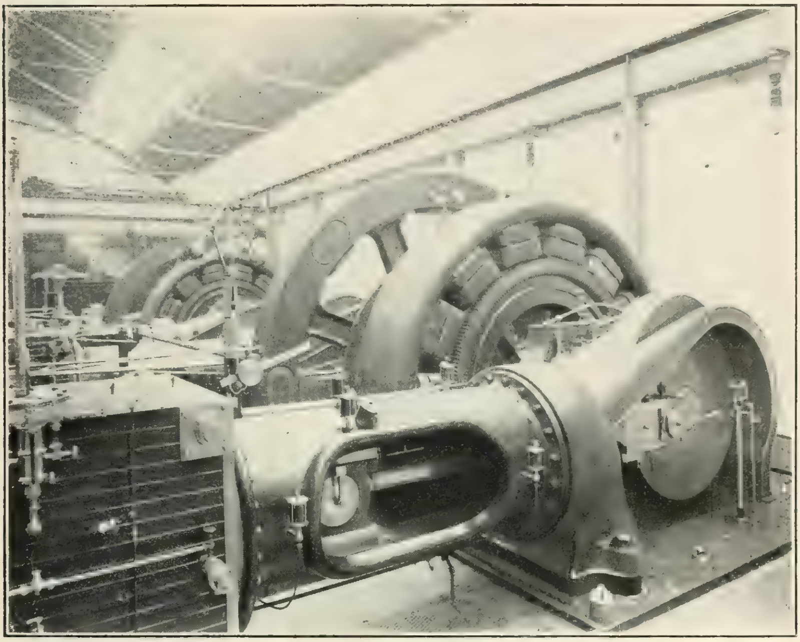
Two 2,550-horse-power Allis cross-compound condensing engines, cylinders 34 and 70 inches by 54 inches, 80 revolutions, and four 1,250-horse-power Allis cross-compound condensing engines, cylinders 26 and 54 inches by 40 inches, 80 revolutions, all direct connected to Westinghouse generators. The maximum horse power of the larger engines is 4,000 and of the smaller 2,000; this is reached nearly every morning and evening during the winter months.

The pressure on the projected area, that is to say, on the area equal to diameter and length, of a main journal should in no case exceed 150 pounds per square inch. As regards crank pins and cross-head pins, American practice might with much advantage be altered, and the pressure per square inch of projected area decreased. The standard English mill-engine practice perhaps goes to extremes, but it is preferable to the American practice. As an example we will consider a cross-compound vertical engine designed to work at a steam pressure of 150 pounds per square inch running 80 revolutions per minute. The cross-head pin in British practice would be 7 by 10 inches and the crank pin 9 by 11 inches. The corresponding dimensions of an Allis engine to do the same work and with same dimensions as regards cylinders, stroke, speed and steam pressure would be:—cross-head pin 6½ by 6½ inches; crank pin 6½ by 6½ inches. That this is large enough to avoid heating is undoubted, but if knocking is to be prevented the liners of these smaller pins will require taking up much oftener than would be the case with the British engine. Taking another example, say an engine designed to develop 800 indicated horse power and able to develop 1,000 horse power continuously at a pressure of 150 pounds steam at 90 revolutions per minute; this would have cylinders 22 by 44 inches and 42 inch stroke, cross-head pins of 6½ inches diameter by 7 inches long, and crank pins of 7 inches diameter by 7 inches length would give complete satisfaction. The standard American practice for such an engine would be crank and cross-head pins both 6 by 6 inches. Or, in other words and in round figures, the projected area of the cross-head pin should be 20 per cent. greater and that of the crank pin nearly 30 per cent. greater than standard American practice.

The outside finish of Continental engines, particularly, is much better than is usual with Americans. Nearly all bright parts are polished. The rim of the fly-wheel is polished. Burnished or Russian steel sheathing is used, and all the hand rails are bright. In connection with German engines it is interesting to notice that, owing probably to the prevailing depression in Germany which forces them to sell at any price, they have secured orders for steam engines in the heart of Lancashire at prices lower than either British or American tenderers, and besides they have accepted one-third of their payments in debentures.

Horizontal and vertical engines. In Germany some engineers state they will always use horizontal engines with tail rods carried on regular cross-heads and slides, because their original cost is less, and because the machine is less complicated and its working and supervision when running are easier. Had such complicated structures with two cylinders, one above the other, and highly complicated valve gear not been originally installed, it is doubtful whether such a conclusion would have been reached.

Continental engineers like to place a dynamo on each side of the engine. In some cases in cross-compound engines, as for instance Tosi, the two cylinders are side-by-side, and to look symmetrical some



PHILADELPHIA UNION TRACTION COMPANY POWER STATION AT 13TH AND MT. VERNON STREETS.

Four Wetherill twin tandem-compound non-condensing Corliss engines, cylinders 26 and 4 inches by 48 inches, 80 revolutions, direct connected to 1,500-kilowatt Westinghouse direct-current 550-volt generators. A fifth similar unit is now being installed.

engineers have even gone as far as to place the dynamo on one side and the fly-wheel on the other side of the engine, which it need hardly be pointed out is very bad practice.

In connection with the large combined horizontal-vertical engines which are being installed in the power stations of the Manhattan Elevated Railway at New York, it should be noted that the design there adopted is by no means novel, but is to be found, in much smaller engines it is true, in Germany, at Halle, where a similar type, although of relatively very small size, was being installed about 1892. Germany has adopted triple-expansion engines both for traction and lighting work. Also the use of superheated steam is greatly on the increase. The steam pressures used with these engines are 12 kilogrammes per square centimetre, about 175 pounds per square inch, and the temperature at the throttle 280 to 324 degrees centigrade, or a superheating of about 130 to 200 degrees Fahr. It is this degree of superheating which accounts, notwithstanding the complications frequently introduced, for the nearly universal use of poppet-valve systems on the Continent.

To increase the efficiency of steam plants, the Continental engineer has increased the vacuum of the condensers as much as possible and a far greater quantity of condensing water is used than is usual in America, the Continental practice being about in volumes 30 to 1 as compared to the American of 25 to 1.

Examining the types of engines in use. What is economy in a power and traction station? Engine economy guarantee at rated load is not the real measure, as loads are very variable. To ascertain what the real economy is we must know what is the variation in large plants and what is the average load on engines in these circumstances. Cross-compound condensing units give good results. The variation of temperature in the low-pressure cylinder is very small because of the reheater receiver. Such an engine is practically two single engines with each cylinder acted upon by a governor; it consists of two engines with smaller ranges of temperature variation. This is American practice. Engines for this class of work necessitate ample receiver capacity.

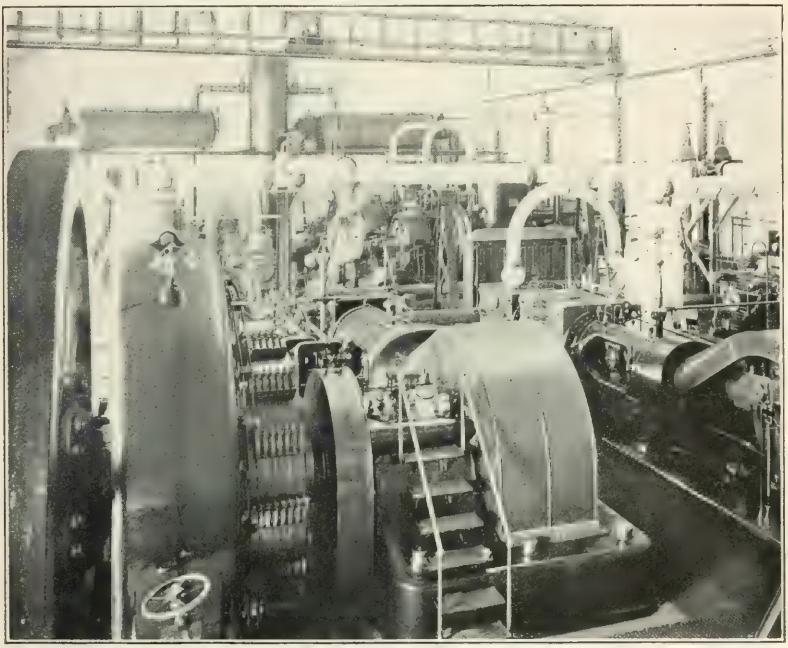
It has been suggested to adapt triple expansion to traction work and variable loads by using a throttle governor on the high-pressure, an automatic on the intermediate, and fixed cut-off on the low-pressure. A sudden overload would quickly raise the initial steam pressure and let out the cut-off on the high pressure; the intermediate automatic cut-off would provide the balance of power and deliver a fairly constant volume of steam at a slightly varying pressure; the cut-oft being fixed and the vacuum constant, the range of temperature would be fairly constant. During the overloads such an engine would not be economical, but it would be so for the average load for which it was designed and to which it had been regulated.

German and Continental engineers generally try to secure absolutely steady load by the use of large storage batteries, in which case triple-expansion condensing units are to be recommended, and also the use of superheated steam; but although this reduces the cost of the power generated, we must consider the extra cost of the power supplied, due to loss in accumulators and to interest, maintenance, and sinking fund involved by the installation battery. Where money is to be got at a low rate of interest, expensive fuel and water may indicate the use of batteries.

If superheaters are used in the boiler flues, economisers are not much good. If a separate superheater is used the cost of extra fuel, interest, maintenance, and sinking fund must be taken into account in considering economy in steam and coal.

In Great Britain, superheated steam is generally only used with the idea of getting absolutely dry steam at the engines and doing away with the bother always caused by steam traps and separators. Consequently economisers are much used, and it is undoubtedly a fact that for compound condensing plants, economisers, when used in connection with mechanical stokers, give the best results.

Cooling towers and cooling ponds for condensing water are much in vogue on the Continent. In America cooling towers are also used as designed by Worthington, Wheeler-Condenser Co., and others, but with the difference that mechanical draft is created by the use of fans, whereas Continentals build their towers of wood and of sufficient height to create a sufficient draft.

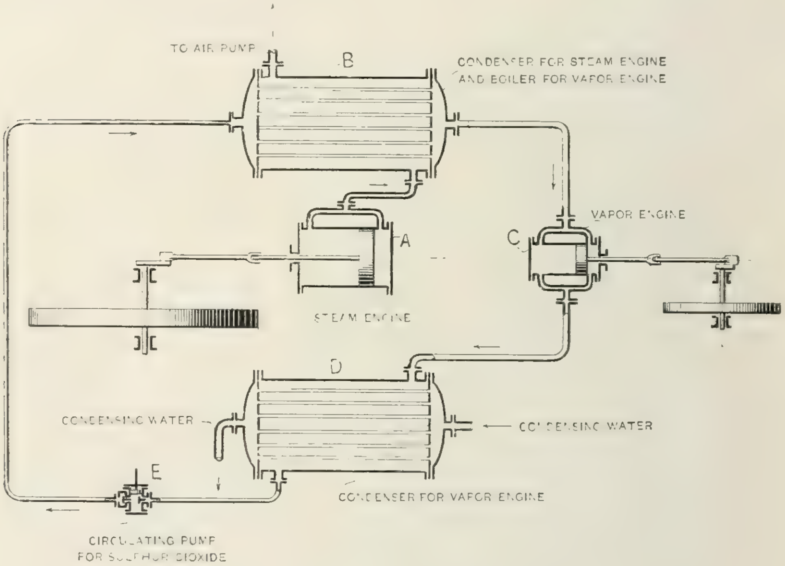


UNION TRACTION COMPANY, PHILADELPHIA. POWER HOUSE AT 33RD AND MARKET STREET.

Two Wetherill twin tandem-compound Corliss engines, cylinders 26 and 40 inches by 48 inches, non-condensing, direct-connected to 1,500-kilowatt Westinghouse direct-current generators; also one cross-compound condensing Corliss engine built by the Penna. Iron Works, cylinders 30 and 60 inches by 60 inches, 80 revolutions, steam at 150 pounds, direct-connected to a 1,500-kilowatt Westinghouse direct-current railway generator; also three Westinghouse "Kodak" units of 500 horse power each. This is not regarded by the company as at all an ideal power station, having grown up by accretion under urgent pressure. It is likely soon to be replaced by a thoroughly modern plant.

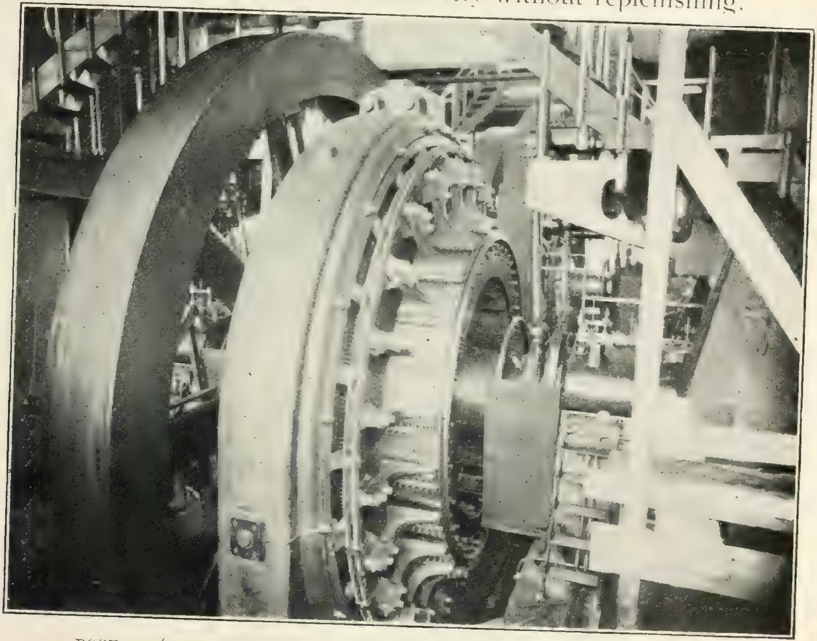
It is curious to note that in the case of the Berlin Electricity Works, where the greatest care has been taken owing to the cost of coal (over

20 shillings a ton) to reduce fuel consumption, and where in view of the size of the plants small economies would soon mount up, the engineers in charge of these stations have stated to the writer that after careful tests they find it cheaper to stoke by hand, which they do in all their stations. British experience, which is confirmed by American practice, is to use mechanical coal-and-ash conveyors, in conjunction with weighing machines over each boiler, and to employ exclusively mechanical stoking.



THE JOSSE BINARY VAPOUR ENGINE.

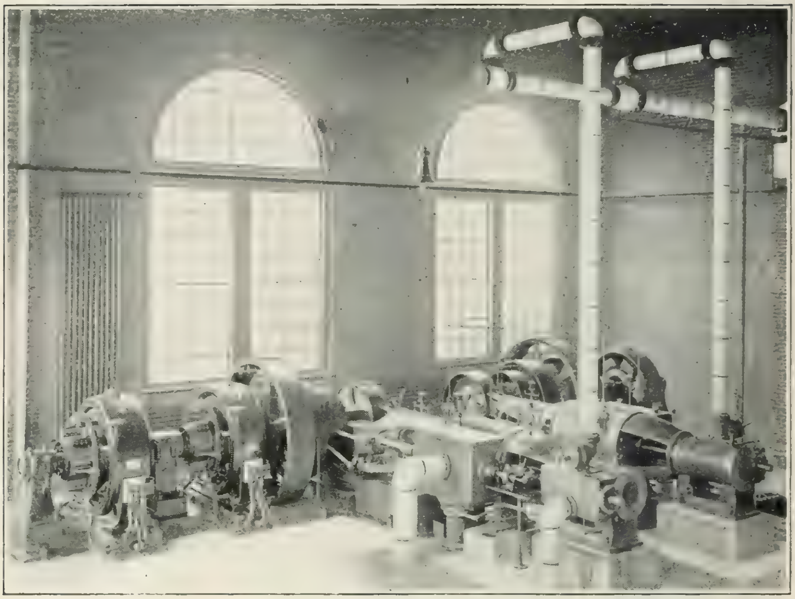
The waste-heat engine being experimented with in Berlin is an entirely novel departure, and as it is being taken up by the Allgemeine Elektricitäts Gesellschaft on a commercial scale, I shall say a few words about it. Speaking broadly, the principle of this engine is as follows:—The exhaust steam from a steam engine is condensed in a surface condenser, which uses, instead of water as in the ordinary way, some liquid of a very low boiling point. The heat of the exhaust steam evaporates the cooling fluid and the vapour thus obtained is utilised in a separate cylinder, and useful work obtained from it. After a considerable amount of trial and experiment on the part of Professor E. Josse, of Berlin, SO_2 was selected as the most suitable material with which to work. Liquid SO_2 is therefore used to condense the exhaust steam, and being vaporised in the process is capable of doing useful work, either in a supplementary cylinder to the steam engine, or in a separate engine. The figure opposite, which is a diagramatic drawing of the general arrangement, should serve to make matters clear The steam engine A exhausts into the surface condenser B, through which flows liquid SO_2 instead of water; here the SO_2 is vapourised. The vapours so obtained develop power in a special cylinder C, by expanding down to a pressure approximately corresponding to the temperature of the circulating water. Under this pressure the SO_2 gas passes on to a second surface condenser, D, where by means of circulating water it is again liquified. E is a small pump which delivers the liquid SO_2 from the condenser D to the condenser B, from which point it commences its cycle afresh. Hence, neglecting loss by leakage, the working medium can be used indefinitely without replenishing.



BOSTON (MASS.) ELEVATED RAILWAY, LINCOLN POWER STATION.

Two Rice & Sargent engines driving one General Electric and one Westinghouse 2,700-kilowatt direct-current dynamo. The engines are duplicates, with cylinders 44 and 88 inches by 60 inches stroke, 75 revolutions, 160-pounds to 180-pounds steam pressure, 4,000 horse power.

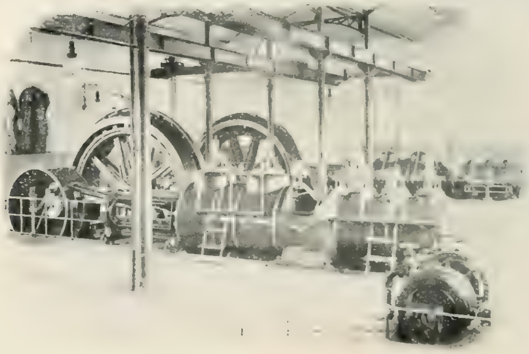
In theory this is all perfectly simple, but in practice it is not quite so easy. SO_2 in the presence of air and moisture rapidly changes into H_2SO_3 (sulphurous acid), which attacks metals, so great precautions had to be taken to render leakage impossible. This was a work of time, but eventually Professor Josse, to all intents and purposes, overcame these and other mechanical difficulties and has obtained some



AUXILIARY PLANT, BOSTON ELEVATED RAILWAY SYSTEM.

excellent results from experiments made under his superintendence. There is one great advantage about liquid SO_2 in that it is an excellent lubricant in itself. Professor Josse claims to have obtained an increase in power of an ordinary steam engine of from 30 to 34 per cent. by using his supplementary cylinder working with SO_2.

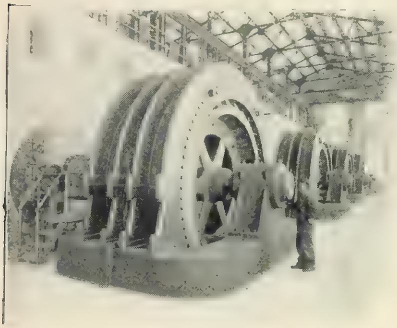
It is hoped that the foregoing remarks will be taken in the spirit in which they are written, namely, of friendly criticism and praise—an attempt to point out the faults and good points in all cases. That the engine builders of all countries have succeeded in developing in their respective branches and countries such magnificent machines is a fact of which all engineers without national distinction should be proud.



THE ECONOMY OF ISOLATED ELECTRIC PLANTS.

By Isaac D. Parsons.

In connection with Mr. Parsons' preceding article in our January number, we called attention to the rare value his analysis of costs possesses by virtue of its concentration of absolutely accurate data only, out of a very large range of investigation. This article concludes the discussion by a review of the yet more difficultly accessible field of the power plants installed in residential buildings.—THE EDITORS



HAVING in the previous article discussed comparative cost of public and private electric supply as obtained from exact records of the business buildings of New York, the buildings which are used for residential purposes, including apartment houses, hotels, and clubs, will now be considered. The apartment houses will be discussed first. Great difficulty was experienced in obtaining any figures from these buildings, and of one hundred and fifty first-class apartment houses over five stories in height which were visited, not over fifteen had plants installed, and of this small number all but three were complicated by hydraulic elevators or had no reliable records of output or supplies. That so few plants are installed in apartment houses is due principally to two causes. First, the load in such buildings is somewhat unfavorable for a plant, thus rendering its advisability doubtful; and, second, many of the apartment houses, especially in the up-town districts, are built with the intention of selling them as soon as possible. If a plant is installed it adds considerably to the original cost of the apartment house, and instead of being an inducement has been found to be a hindrance to the sale of the building. No plant is therefore installed when the apartment house is erected, and the building, in most cases, is so arranged as to render the installation of a plant at any future time either impossible or a matter of much difficulty.

Building No. 10 is representative of a type which includes more than half of all the better-class apartment houses in New York in which

All buildings heated by steam. All engines simple non-condensing and all direct connected to generators except in building No. 17, where they are belted.

Building number	10	11	12	13	14	15		16	17
Type of building	Ap't H'se	Ap't H'se	Ap't H'se	Hotel	Hotel	Club		Club	Club
Number of floors	7	10	11	6	9	5		3	4
Ground plan	90x65	44x81	50x200	100x200	25x60	35x100		75x200	110x100
Number of electric elevators	1-15 H. P.	2-20 H. P.	3-25 H. P.	....	2-15 H. P.	....		1-20 H. P.	....
Floors of building lighted	All	All	All	1st & 2d	All	All		All	All
Number of Generators	2	2	3	2	2	1		3	2
Total capacity of generators, kilow	45	60	175	66	80	20		130	50
Average load on generators	.48	.20	.60	.50	.67	.40		.40	.75
Voltage	115	240	115	118	115	116		118	118
Type of boiler	Hor. Tub.	Marine	W. Tube	Hor. Tub.	Hor. Tub.	Hor. Tub.		Hor. Tub.	Hor. Tub
Boiler pressure	90	100	125	90	100	.80		90	80
Back pressure	5	2 to 5	3 to 5	4	3 to 6	6		3 to 5	3 to 5
Kind of coal	Pea	Buck	Buck	Pea	Bitum.	Buck		Buck	Buck
Load factor of lighting load	.43	.10	.40	.60	.67	.50		.44	.85
Cost of light, heat and power, with plant installed.									
Time covered by figures	1 year	6 mos.	1 year	* 10 mos.	1 year	5 mos., '00	5 mos., '01	1 year	1 year
Labor	$2,280	$1,320	$3,840	$480	$3,690	$325	$325	$2,700	$2,400
Coal and removal of ashes	1,995	936	5,563	620	5,530	263	389	1,355	1,551
Water	164	64	303	60	480	22	30	117	196
Oil and waste	136	72	240	92	339	6	6	56	90
Lamps	28	8	136	40	354	5	6	24	93
Repairs and sundries	45	46	200	50	500	16	16	112	90
Interest and depreciation	572	495	2,376	880	1,045	115	115	1,100	770
Central station service		300							584
Total	$5,220	$3,241	$12,658	$2,222	$11,044	$752	$887	$5,464	$5,774
Output—Light K. W. hours	55,730		182,360	115,000		6,306	9,407		68,513
Output—Power K. W. hours	26,400		50,000						
Output—Total K. W. hours	82,130	26,605	232,960	115,000	329,500	6,306	9,307	93,800	68,513
Cost per K. W. hour	$0.064	$0.120	$0.055	$0.019	$0.037	$0.12	$0.09	$0.057	$0.084
Tons of coal consumed	570	312	1,919	1,007	1,826	75	111	466	486
Pounds coal per K. W. hour	15.5	25.1	18.4	13.5	12.4	26.7	26.4	11.1	16.6
Probable cost of light, heat and power for same period if no plant installed.									
Central station bill	$7,351	$2,199	$11,330	$5,750	$15,650	$753	$908	$7,770	$5,841
Labor	600	300	1,600		1,300	125	125	720	720
Coal	650	672	1,400		150	240	240	910	600
Total	$8,601	$3,171	$14,330	$5,750	$17,050	$1,118	$1,273	$9,400	$7,161

* These figures are the cost of generating electricity only and do not include the cost of heating.

TABLE 4. POWER EXPENSES AND OUTPUT FOR ONE YEAR OF EIGHT RESIDENTIAL BUILDINGS.

elevators are installed. The dimensions of the building, as well as a general description of its plant, are given in Table 4. The figures of both kilowatts output and expenses were obtained from the chief engineer and superintendent. The output was calculated from ammeter readings. Steam is used for heating the building, for the generation of electricity, and for a small house pump. The expenses of running the plant and heating the building, and the output of the plant for one year, as well as the probable cost of running the building were no plant installed, are given in Table 4. The gain by the installation of the plant is thus \$3,381, or 40 per cent. of the total cost of running the building were current supplied from the central station.

The figures concerning building No. 11 show how, principally through a mistake in installation, a very similar plant is operated at a loss. The plant in this apartment house not only furnishes light, heat, and power for the building itself, but also supplies heat and light to the adjoining four-story house which is 25 by 65 feet in plan. The output was calculated from daily wattmeter readings and the expenses of operation were obtained from the superintendent. Figures as to output, unfortunately, were available for only eight months. In Table 4 are given the expenses of running the plant and heating the buildings for the six months from October to March inclusive. The cost per kilowatt hour, which is very high, includes the expense of heating, and since heating was necessary during all of the six months, this has some effect in increasing the cost to so large a figure.

Fortunately figures for the same year were available of the expense of heating an apartment house exactly similar to building No. 11 in shape and exposure, and differing from it in cubic contents by approximately 75,000 cubic feet, which is the volume of the adjoining house heated by the plant in building No 11. It has been found, as mentioned in the first article, that the amount of coal necessary to heat 1,000 cubic feet is practically independent of the size of the building, so that these figures can be used without error in calculating the total cost of running building No. 11, if electricity were obtained from a central station. These expenses are given in Table 4 and in further detail in Table 5, and when added to the cost of current, were it obtained from the central station, the sum is in most months considerably less than the cost of operating the plant. This entails a net loss during the year of \$600 to \$800. The boilers in buildng No. 11 were found by recent test to evaporate nine pounds of water per pound of coal, and both engines and dynamos are new and in good condition, so that the lack of economy seems due entirely to very low efficiency caused by light load on the generators. A comparison of the methods of operating the generators in this building and in building No. 10 will best show the reason for the difference in the cost of operating the plants. In building No. 10 the lighting load from 7 A. M. to 5 P. M. is on an average about 25 amperes, which necessitates running the smaller of the two dynamos, (one having a capacity of 130 and the other of 260 amperes) at about one-sixth full load excepting when the elevator is in use, when the generator is momentarily forced to its full capacity. At night the lighting load increases to about 180 amperes, which, with the elevator load, exceeds the capacity of the larger machine. Both generators are therefore run, one supplying the lights and the other the elevator, an arrangement which has the advantage of avoiding the fluctuation in the lighting voltage due to the elevator-starting current. The maximum lighting load does not exceed 200 amperes, so that the larger generator operates at night at 70 per cent. full load, and the smaller dynamo, when loaded at all, is loaded to about the same extent. This arrangement enables the machines to be operated with fair efficiency. The generators are stopped at about midnight and started again at 7 A. M., gas being used for lighting the building during the intervening hours.

In building No. 11 one of the two 30-kilowatt generators is in operation daily from 7 A. M. till midnight, and from 7 A. M. to 5 P. M. it carries both elevator and lighting loads. The other dynamo is used only from 5 P. M. till midnight, when it supplies either the elevator or the lights. Although the lighting load during the day is only 15 to 20 amperes, it is necessary to run a 30-Kilowatt generator, since when both elevators are in operation at once a machine of smaller capacity would be insufficient. The load on this machine during more than three-quarters of the time, from 7 A. M. to 5 P. M., is, however, but one-sixth of its capacity. During the evening, when both generators are in operation, the one furnishing power to the elevators is running for five hours out of the seven from 5 P. M. till midnight absolutely without load, and during the remaining two hours the average current furnished is not over 50 amperes, or less than one-half the machine's capacity. The lighting generator during the evening carries a load which never exceeds 60 amperes and it could be replaced by a 15-Kilowatt machine with considerable advantage. If we assume 12 per cent. friction loss in the engines and 85 per cent. full-load efficiency for the dynamos, the average efficiency of dynamos and engines combined is in this plant but 39 per cent., while the plant in building No. 10 shows an average efficiency of dynamos and engines combined of over 57 per cent. Steam in both buildings is used only for heating, for a small house pump, and for the electric plant.

Table 5, in addition to giving the detailed expenses of building No. 11 for eight months, shows very clearly the important part which heating plays in the economy of the isolated plant, the coldest months when the most heating is necessary showing the greatest economy. The variation of the average daily load in building No. 11 from month to month and the change in load from day to day in January and October are shown in Figures 10 and 11 respectively. Though buildings No. 10 and No. 11 are very similar in size, it will be noticed that the yearly output in the former is much the greater, which is explained by the fact that the tenants of building No. 10 are furnished with unlimited light free, while in building No. 11 it is furnished to them at central-station rates.

Date.	K. W. Hours Light & Power Generated in Plant.	K. W. Hours obtained from Central Station.	Tons Coal used by Plant.	Pounds Coal per K. W. Hour.	Cost of Running Plant (includes cost of heating).	Cost of obtaining same number of K. W. Hours from Central Station.	Tons of Coal necessary for Heating only.	Total Cost of running Building with Central Station Service.	Amount Gained or Lost by Installation of Plant.
June, 1900......	2,961		30	22.6	469.59	280.10	6.0	348.10	Loss 121.49
October, 1900....	3,225.6	171.6	42	29.2	508.07	317.74	14.5	411.24	Loss 96.83
November, 1900..	3,909.6	91.8	46	28.4	520.88	350.17	31.0	493.17	Loss 27.71
December, 1900..	4,432.0	160.8	63	31.9	575.40	400.96	43.0	579.96	Gain 4.56
January, 1901....	4,829.6	97.8	63	29.3	575.54	433.42	49.0	630.42	Gain 54.88
February, 1901...	4,032.8	117.6	56	31.2	552.94	364.66	51.3	568.56	Gain 15.62
March, 1901.....	3,696.0	113.4	42	25.8	508.16	332.16	35.0	487.61	Loss 20.55
April, 1901......	3,645		45	28.7	517.67	307.40	20.0	417.40	Loss 100.27

TABLE 5. DETAILED EXPENSES OF AN APARTMENT HOUSE (NO. 11) FOR EIGHT MONTHS.

In building No. 12, a large apartment house, the output of the plant was calculated from average ammeter readings procured from the chief engineer, and the expenses of operation were also obtained from him. The generators are in operation night and day, as there is no connection with the central-station mains and no gas is used. Besides its use in generating electricity, steam is employed for a refrigerating machine, for steam cooking apparatus, for a laundry, and for a large house pump. The results of recent tests to determine the coal used for these machines show a consumption of 978 tons per year, and since the total amount burned for all purposes for one year was 2,897 tons, the quantity chargeable to the electric plant and to heating is 1,919 tons. Of the employes, one man could be dispensed with were the refrigerating plant, etc., not installed, and his pay has, therefore, been deducted from the wages item in the list of expenses given in Table 4. The output of the plant and the probable expenses, were

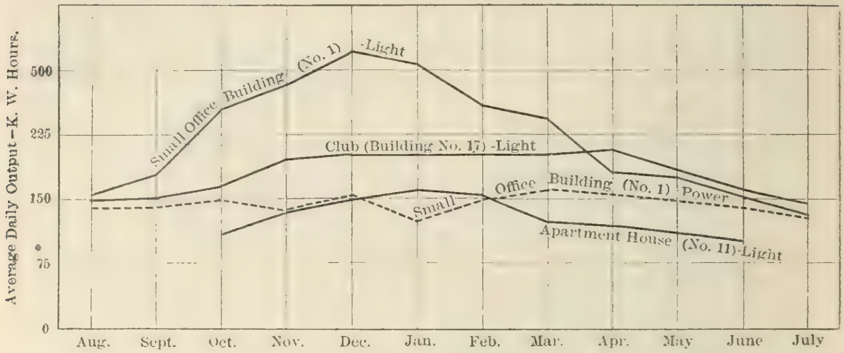


FIG. 10. VARIATION OF AVERAGE DAILY LOAD FROM MONTH TO MONTH.

current obtained from central station, are also given in the table and show the comparatively small gain of $1,670 for the isolated plant. This small gain is due mainly to the large coal item, which is 44 per cent. of the total expense of operation. The reason for the large amount of coal burned was found to be the bad condition of the boilers, which contained much scale and therefore evaporated less than five pounds of water from and at 212° per pound of coal. Were a normal amount water evaporated, such as 8.5 pounds per pound of coal, the coal item would be decreased by about $2,200 and the cost per kilowatt hour would be reduced to less than $0.045.

The statistics of these three apartment houses indicate that this class of buildings can be run at much less cost with the isolated plant than with the central-station service, provided the plant be properly installed and economically operated; but the gain by the plant is smaller than in the other classes of buildings we have considered, and great care must be exercised lest this gain be turned into a loss.

At a large apartment house ten stories in height and 100 by 100 feet in plan, having a large restaurant on the ground floor, hourly readings were taken of the amperes used for lighting but no records were kept of power output or of expenses. The curves of Figure 13 and the load curves for the apartment house in Figure 16 were plotted from

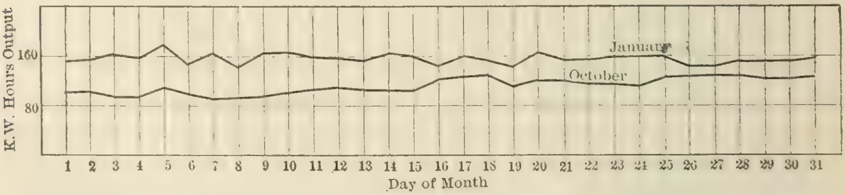


FIG. 11. VARIATION FROM DAY TO DAY OF THE LIGHTING LOAD IN A SMALL APARTMENT HOUSE (BUILDING NO. 11).

the above readings. The plant in this case supplies light for the entire building and power for four electric elevators, and consists of horizontal tubular boilers and three 75-kilowatt generators direct-connected to simple engines.

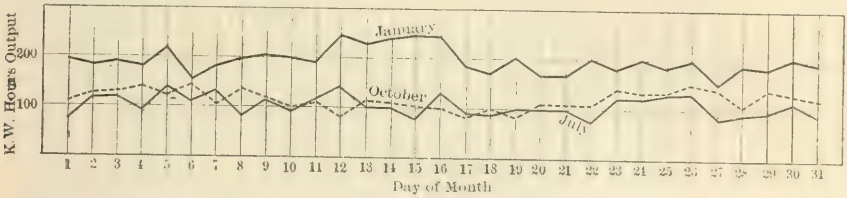


FIG. 12. VARIATION FROM DAY TO DAY OF THE LIGHTING LOAD IN A LARGE CLUB (BUILDING NO 17).

Concerning the economy of the isolated plant in hotels there is very little doubt, as is shown by the fact that nearly all the buildings of this class in New York, both large and small, have installed electric plants. The load in hotels is inherently favorable to the plant, as it is considerably more uniform than in apartment houses of the same size, on account of the large number of lights always burning in the restaurants, parlors, and halls, and the power load is continuous and heavy. Further, in almost all cases a steam plant is necessary to furnish steam for refrigerating machines and similar apparatus, whether current is generated on the premises or obtained from without, so that the extra expense entailed by the installation of the electric plant is small. The presence, however, of hydraulic elevators, refrigerating machines, etc., though rendering the operation of the electric plant economical, made it impossible to obtain reliable figures excepting from very few hotels.

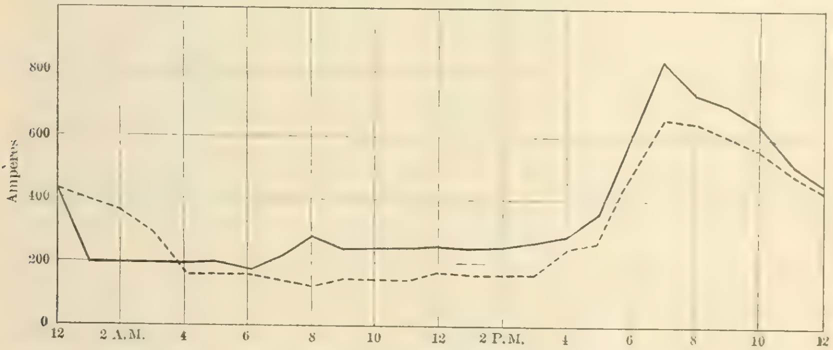


FIG. 13. MAXIMUM AND MINIMUM LIGHTING LOADS IN A LARGE APARTMENT HOUSE DURING MARCH AND APRIL.

Building No. 13 is a hotel which shows excellently how little extra expense is entailed in some cases by the installation of an electric plant. Before the generators were installed, two 125-horse-power boilers supplied steam for elevator pumps operating two hydraulic elevators, for a steam laundry, for steam cooking apparatus, for a 12-ton refrigerating machine, for a 10-horse-power blower engine, and for various other purposes. The electric plant furnishes current for lighting the two lower floors of the hotel only, the same boilers being used as before the installation of the dynamos. Accurate statistics of coal, labor, etc., were available, but the figures concerning kilowatts output are only approximate since no complete daily records are kept. The generators are run throughout the twenty-four hours and the load diagram is shown in Figure 14. The table shows the increase in the expenses for ten months due to the electric plant. The very small increase in the expense for coal is due to the fact that a cheaper grade of fuel was burned after the installation of the generators. One fireman was the only extra employee made necessary by their installation. The cost per kilowatt hour does not in this case include the expense of heating, and would be much larger if reduced to the same basis as the figures of the other plants; but it shows the extremely small cost of generating electricity under the conditions which prevail in this hotel.

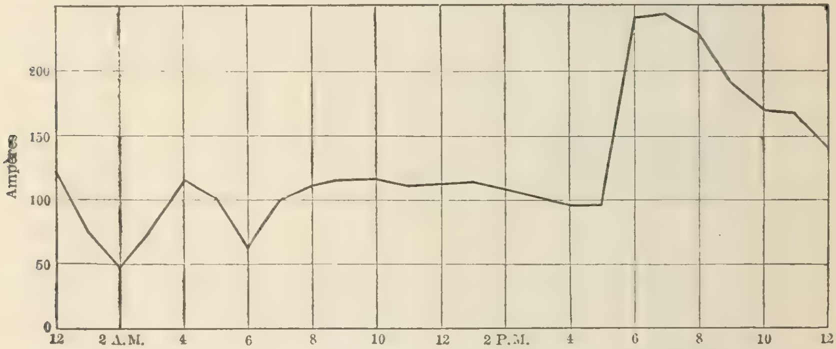


FIG. 14. LOAD CURVE OF A SMALL HOTEL (BUILDING NO. 13) FOR OCTOBER 9.

In building No. 14, which is a small hotel, the output of the plant was calculated from hourly ammeter readings which were obtained from the chief engineer, and figures of the expenses of operation were procured from his books. The only machinery using steam besides the engines driving the dynamos and small feed and house pumps was apparatus for steam cooking, and the amount of coal burned due to this use of steam was approximately 150 tons per year. This quantity of coal, subtracted from the total coal consumption for all purposes of 1,976 tons, leaves 1,826 tons chargeable against the electric plant. The expenses of running the plant and heating the building are given in Table 4 and compared with the probable expenses, if the central-station service were used, the installation of the electric plant brings about an annual saving of $5,100. So large an output in so small a building is accounted for by the large amount of electricity used for power and by the great number of lights always in use in the restaurant. Not only are two electric elevators run, but a 10-ton refrigerating machine, a brine pump, and several large ventilating fans are operated electrically, and since the ice machine, pump, and fans are in use twenty-four hours a day the load on the generators never falls below 250 amperes. These conditions enable the dynamos to be operated at loads giving high efficiency and help to bring about the low cost per kilowatt hour.

In a large hotel eight stories in height and about 60 by 160 feet in ground plan, where both electric and hydraulic elevators are operated, a dynamo was recently installed, a steam plant for the elevator pumps, etc., having already been in use several years. This dynamo carries a part of the lighting load. It was found during a month when this dynamo was shut down that the central-station bills for the current which the generator had formerly supplied were over 25 per cent. greater than the cost of operating that machine.

In Buffalo, where the conditions as to cost of coal, labor, etc., are not very different from those in New York, and where it would be supposed that the Niagara Falls Power Company could furnish current about as cheaply, compared with the isolated plant, as in any city in the United States, one of the large hotels operates a plant of its own This plant, which is run in conjunction with a large refrigerating machine, is not the most modern nor best of its kind, and yet it shows each year a substantial gain in economy over the central-station rates. From the above facts it seems, therefore, that in the hotel the conditions are perhaps more favorable to the isolated plant than in any other class of buildings.

We will now consider the clubs, the sixth and last class investigated.

The load in these buildings resembles most nearly that in apartment houses, although the elevator load is usually very much smaller and the lighting load is likely at times to attain a higher peak. On account of the very small load during the morning, many clubs take current from the central station during that part of the day instead of running the plant.

In building No. 15, a very small club, the output was calculated from half-hourly ammeter readings taken by the engineer, and the cost of operating the plant was obtained from his records. Steam is used only for the engine driving the dynamo, for small house and feed pumps, and for heating. The 20-kilowatt dynamo is in operation from 4 P. M. to 1 A. M. only, and is run usually at about three-eighths of its capacity, though the maximum load may reach 150 amperes. When the generator is not in operation gas is used for lighting. There is no elevator in the building, so that current for lighting only is supplied. For the months from November to March inclusive in 1899-1900 and 1900-1901, the operating expenses and output of the plant will be found in the table, as well as the probable expenses were no plant installed. The figures show a saving, by the installation of the plant, of about one-third of the total cost of running the building if the central station supplied the current.

Building No. 16 is a large club. The output of the plant was calculated from ammeter readings furnished by the chief engineer and the expenses of operation were obtained from his records. Steam is used only for heating, for the electric plant, and for a small house pump. The plant is in operation from 5 A. M. until midnight, when the building is closed for the night. A potential regulator enables one generator to be used for both elevator and lights during the day, without any disagreeable fluctuations in the lights due to the large starting current when the elevator starts. Although the lighting load from 5 A. M. to 5 P. M. is but 25 amperes, it is necessary to run a large generator since the starting current of the elevator momentarily increases the load to 140 amperes. Since, however, the elevator is in actual motion less than one-seventh of the time, the current used by it has little effect in increasing the average load on the dynamo, which remains too small during the day for very efficient operation. Nevertheless a comparison of the expenses of running the building with and without the plant given in Table 4 shows a saving of nearly $4,000 yearly due to the installation of the plant.

Building No. 17 is another large club. The output of the plant was calculated from half-hourly ammeter readings, and the expenses were obtained from the chief engineer's books. The dynamos are started at about 4 P. M. and are run until 2 A. M., when the plant is shut down. During the time that the plant is not in operation, gas or current from the central station is used for lighting. The load on the generators averages about 75 per cent. of their capacity, and the load factor for the nine hours they are in operation varies from 0.79 to 0.95 according to the time of year, the load being unusually uniform as

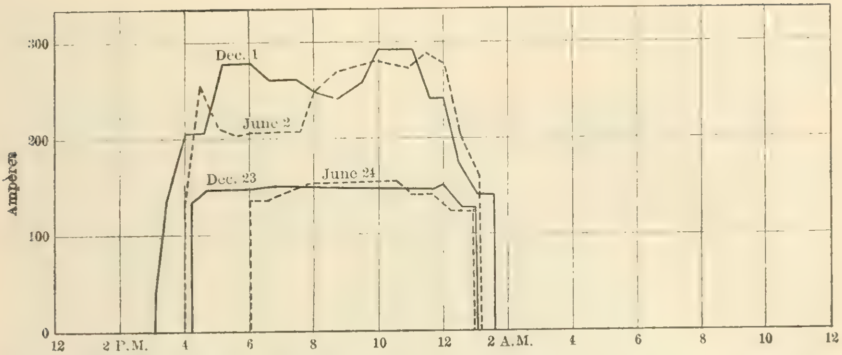


FIG. 15. MAXIMUM AND MINIMUM LIGHTING LOADS IN A LARGE CLUB (BUILDING NO. 17) DURING THE SUMMER AND WINTER MONTHS.

shown in Figure 15. Beside a small house pump, the feed pumps, and the engines driving the generators, steam is used for a small blower engine and for an elevator pump running an hydraulic elevator. This elevator is in operation very intermittently. The amount of coal used for the blower engine and pump is about 294 tons per year, and since the total coal consumption for one year was 780 tons, 486 tons are chargeable to the electric plant and to heating.

The expenses of operation and the output of the plant for one year are given in Table 4 and show a gain by the installation of the electric plant of $1,400 a year, an amount which would undoubtedly be much increased were it not that the boilers, engines, and generators are old-fashioned, having been installed over eleven years ago, and cannot give such high efficiency as a more modern installation.

The large amount of coal burned per kilowatt hour, which includes the coal used for heating, is partly due to the fact that the plant is in operation such a short time daily. There is thus no exhaust, except from the elevator pump, during the morning and early afternoon, and the building has to be heated partly by live steam, which of course results in the consumption of a considerable quantity of coal. The large central-station bill also increases the cost of production considerably. Thus the actual amount of current produce in the plant was 65,593 kilowatt hours at a total expense of $5,190, which makes the true cost of production $0.079 per kilowatt hour—somewhat less than the cost stated in the table. Figure 10 shows the variation from month to month of the average daily lighting load in this building, and Figure 12 indicates the change in load from day to day in January, July, and October. The figures on these three clubs indicate that even if the club is a very small one, or if the plant must operate under unfavorable conditions, the installation of an electric plant will enable the building to be run at considerably less expense than were current taken from the central-station mains.

Figure 16 shows the variation of load as affected by the weather in six of the buildings which have been discussed, each of which is fairly characteristic of its class. The statistics of weather conditions were obtained from the United States Weather Bureau. The curves of Figure 17 show the relation between the total yearly output, on one hand, and the cost of production and the pounds of coal burned per kilowatt hour, on the other hand, in all of the seventeen buildings. The curves pass through many of the points, and the points which lie far outside the curves belong to buildings where peculiarly favorable or unfavorable conditions have been noted.

The statistics of the seventeen buildings which have been discussed in detail show, as a whole, the decided advantage of the isolated plant over the central-station service. It is rather curious, however, that it is usually in the smaller buildings that the greatest percentage of gain is found, this being due partly to the greater proportional saving brought about by heating the building with the exhaust, and partly to the fact that there is more relative difference between the central-station rates which the small building would pay and the cost of production in the isolated plant, than there is between the central-station rate the large building would pay and the cost of generation in its isolated plant. The small plant is, however, much more sensitive to unfavorable conditions of any kind. Though the central-station rate never reaches so low a point as the least cost per kilowatt hour in a very large isolated plant, the decrease as the amount of current increases is greater in the central-station rate than in the cost of production in the isolated plant.

By comparing the results in the different buildings the factors which influence the economy most seem to be:—

First:—The installation of the right number of generators with neither too large nor too small capacity, as a whole, thus avoiding injury from overload and reducing interest and depreciation to a minimum.

Second:—The installation of generators of such size that they may be operated, as nearly as possible, at full load. This is a consideration of great weight, as has been shown in the case of several of the buildings discussed. What the proper sizes are is, however, a somewhat difficult problem to solve, as in installing a plant in a new building the load conditions to be met are somewhat doubtful, and even in a build-

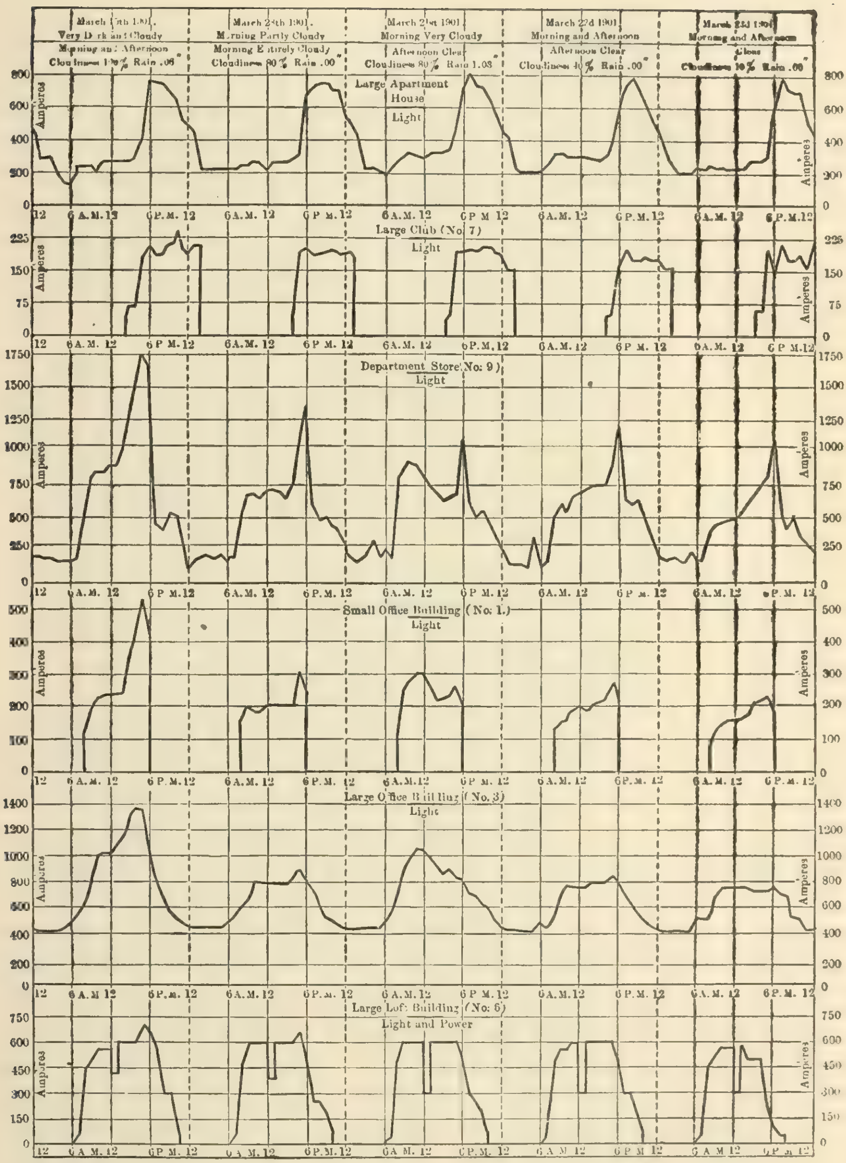


FIG. 16. VARIATION OF LOAD AS AFFECTED BY WEATHER. WEATHER CONDITIONS WERE OBTAINED FROM U. S. WEATHER BUREAU.

ing formerly lighted from the central station the installation of an isolated plant often so changes the conditions as to upset the most careful calculations.

Third:—Heating in the smaller buildings is a very important factor, and, in some cases, the current is produced for exactly the price at which it would be furnished by the central station, the only gain being the cost of heating. Could the central station supply steam at low rates along with electricity, the days of the isolated plant, in the smaller apartment houses and clubs and in many loft and office buildings, would be numbered. When the building is large, the amount which would be expended for heating, were no plant installed, is still gained; but it is a much smaller proportion of the total cost of running the building, and is relatively a less important factor.

Fourth:—The shape of the load diagram has a considerable influence on the economy, and the buildng with a high peak to its load must have machines which are used but little and whose cost increases the items of interest and depreciation considerably. The curves for the two office buildings shown in Figure 2* are examples of favorable and unfavorable load curves.

Fifth:—Where other machinery using steam is present beside the electric plant, a considerable reduction in the cost of labor may be brought about by combining the employees necessary for running the electric plant alone and those who would be necessary for the other machinery if no electric plant were installed.

Sixth:—The keeping of careful daily records of output, supplies, and expenses may have very important results in the way of economy If these records are inspected daily, or even weekly, by the agent in charge of the building or by the owner, they indicate at once, if properly kept, whether there has been laxity on the part of the employees or waste of supplies, and, even if the reports are handed in and never looked at, the fact that a record has to be made and that it is possible to ascertain by it the conditions prevailing in the plant has been found to exert a beneficial influence. Further, by comparing records of different weeks or months, the engineer can find whether his plant is working more or less economically, and in addition the results of any changes he may make in apparatus or management can be ascertained, approximately at least, from these same reports. Careful records also may lead to the discovery of the inefficiency of the boilers, the poor quality of coal, or wasteful use of current which might otherwise have remained unknown, but which is indicated in the records by extraordinary increase in the output or in the expense of operation.

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* The Engineering Magazine, January, 1902, page 579.

(Nov) [illegible] – Precast Concrete Jacques Boyer
[illegible] engineering [illegible]

[illegible] [illegible] expanding [illegible] –
materials [illegible] ~~[illegible]~~ of cinder or sponge
[illegible] system with [illegible]
following the [illegible] and whole in
[illegible] concrete. If pipe of moderate diameter they can be
made in moulds & [illegible] by sleeves. If large may be
made in place. These pipes [illegible] not satisfactory as there is
leakage due to porosity, also porosity ranging from
13 to 33%. If reinforcement [illegible] (3 40 to 637 lbs) of
cement per cubic [illegible] sand [illegible] a [illegible]
happen [illegible] with CO_2 to
form insoluble carbonate & fill the pores. As an example
describe the Bonna system which is extensively used.
[illegible]

[illegible] a different [illegible]

[illegible] This style like the preceding. [illegible]

[illegible] in one [illegible]

[illegible]

[illegible]

[illegible] in a high degree.

[illegible] are made with steel [illegible]

[illegible] paper and pencil [illegible] Paper are

[illegible]

[illegible] large [illegible]

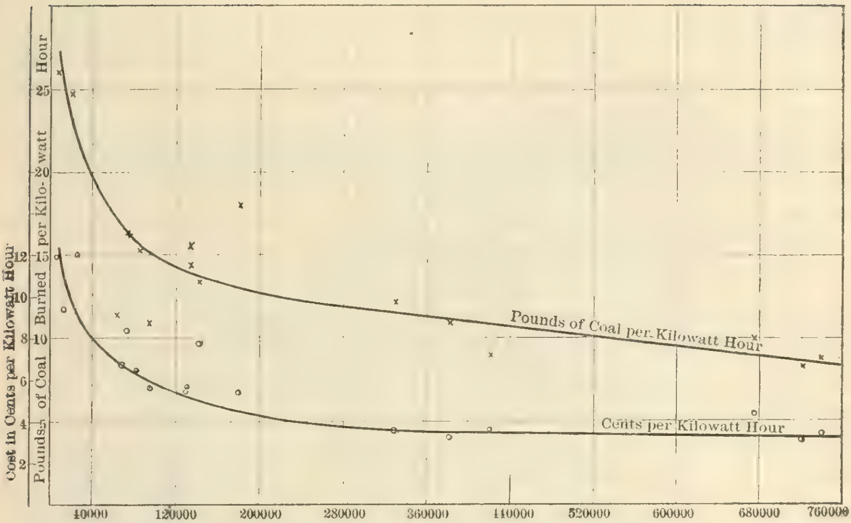

FIG. 17. TOTAL YEARLY OUTPUT. KILOWATT HOURS.

Seventh:—The character of the engineer was found in almost every case to be reflected in his plant, and his competency or incompetency exerts a most important influence on the economy of its operation.

Eighth:—The temperature and ventilation of the engine room or storage-battery room may be of consequence with respect to economy. Not only will dynamos operate more efficiently when placed where the temperature is not excessive, but any machinery in a room where the temperature reaches 140 degrees F. will not be taken care of properly by the engineeering force, whose only thought, naturally, is to finish their work as speedily as possible and get out into a cooler atmosphere. In one plant where the cost of installation did not exceed $9,000, $2,500 had to be expended in repairs during the second six months of operation. These repairs were made necessary simply by negleect on the part of the engineers, who avoided as much as possible any labor in the engine room where the thermometer stood at 140 degrees to 150 degrees F. In another building, a $20,000 storage battery depreciated in the first two years after its installation at least $8,000, from neglect caused by its being placed in a low ceilinged, unventilated room. The crowding together of the machinery may be undesirable from the point of view of convenience, but high engine-room temperature and poor ventilation seem to have far more unfavorable effects on the economy.

Ninth:—The amount of coal-storage capacity may have considerable influence on the cost of operation, for not only does large capacity enable coal to be bought by the boat load at a lower price per ton than if it were purchased in small lots, but in case of a severe snow storm or a strike of men connected with the handling of coal, it may save the plant from the necessity of shutting down and thus either depriving the tenants of light and elevator service and causing great dissatisfaction, or making it necessary to use, for a time, current from the central-station mains, for which high rates must be paid.

Tenth:—The type and number of elevators used, apart from their efficiency as elevators, affects the economy of operation. Of this the last two buildings Nos. 16 and 17 furnish examples. In building No. 16 an electric elevator is used and necessitates the operation of a large dynamo most of the day at an extremely light load, whereas were no elevator present, or were an hydraulic elevator used, a very small machine (4 kilowatt) could be employed, since the load is constant at 30 amperes; or this small amount of current could be taken from the central station at very little extra cost, as is the case in building No. 17. In this connection the potential regulator may play an important part, for without it or a storage battery, the operation of a lightly loaded dynamo, or even a heavily loaded one, for supplying both elevator and lights is practically impossible without extremely disagreeable fluctuation in the lights whenever the elevator starts. When several electric elevators are installed a separate machine can of course be run to supply the elevators alone and still operate at a fairly efficient average load; for the greater the number of elevators the more the resulting current will tend to be fairly uniform.

Eleventh:—The storage battery is one of the most important factors in the economy of the isolated plant, and it furnishes another means by which electric elevators can be run from the same dynamo as the lights and at the same time sudden fluctuations in voltage can be avoided. Further, when the storage battery is used the dynamo does not have to supply all the sudden rush of current as the elevator starts, and the battery enables the generators to be run at or near full load during most of the time the machines are in operation. In a building with a peaked load-diagram the battery can be used to carry the peak, thus avoiding the installation of little-used dynamos and engines and perhaps of an extra boiler. Again, by charging during the day and discharging at night, the outlay for labor may be much reduced, the use of central-station supply may be avoided, and opportunity given for repairs to all the engines and generators.

OPPORTUNITIES FOR IMPROVEMENT IN MICA MINING.

By George W. Colles.

The time was, not many years ago, when a few tons of mica would have glutted the market. Now, in consequence of the large and growing use of mica in the electrical manufacturing industry, its mining is becoming one of the important minor mineral industries. Rather curiously, this close relation to the most modern of developments has not yet lifted mica mining out of the crudities of old-fashioned and laborious methods of working. Mr. Colles' paper may serve to direct attention to the needs and the opportunities of a neglected corner of the mining field.—THE EDITORS.

MICA is peculiar among the infinitely varied products which civilization has called into requisition for general usefulness, in that it is well-known to all and yet its nature and manner of production are very little understood—so little, indeed, that it is often confused in the popular mind with the utterly different substance, "isinglass" (a corruption of the German *hausenblase*, —sturgeon-bladder) to which it bears a superficial resemblance. Nor, when its common occurrence is considered, is it readily apparent why it should sell in quantity at prices which rank its value by weight with those of the precious metals.

That mica is one of the most universal and common of the minerals that make up the earth's crust is a fact known not simply to geologists, but which may be observed by anyone, as its glassy lustre proclaims its presence in granite, gneiss, schists, and the like, and in some places the ground is literally covered with it. In these common rocks, its two usual associates are quartz and felspar, these three combining to make up the stone called granite. All three are products of terrestial heat, and are invariably formed where the proper constituents are present and the cooling takes place with sufficient slowness, and they are accordingly characteristic of metamorphic and igneous rocks. The coarseness of the rock thus formed bears a direct ratio to the rate of cooling, and only in the case of igneous rocks, i. e., where the material has been completely fused, are the individual crystals of mica, quartz, and felspar found in any considerable size, and then only when the cooling has been with extreme slowness—has extended, we may suppose, over years, decades, or even centuries—so as to allow each crystal as it forms to grow by accretion, and the different minerals to crystallize in order as their respective points of solidification are reached.

Thus we arrive at the gigantic form of granite called pegmatite, in which most of the commercial mica is found, and which is still made up of mica, quartz, and felspar, but in crystals varying from the size of one's head up to that of a small house. But while in such igneous formations both quartz and felspar occur in mountain masses individually, mica is found only in comparatively small blocks or agglomerations of blocks, associated with other minerals. Not even all pegmatite contains mica; on the contrary, most pegmatite is made up of quartz and felspar only, and even when mica is present it occurs only with the greatest irregularity and uncertainty. The pegmatite occurs in what are known as "dikes," by the geologists, or by the miner less correctly as "veins." They are not true veins, however, but intersect the strata at all angles and in a very erratic fashion, running hither and thither, branching, suddenly widening or narrowing, and at times disappearing altogether, perhaps to recommence again in a nearly parallel vein a few feet further on. On the surface of the ground they are scarcely ever continuous for more than a few hundred feet.

But the mere finding of a pegmatite dike, even in the mica region, gives no necessary indication of the presence of that mineral. On the contrary, experience shows that in only a few regions of the earth occur dikes which contain mica in paying quantities, and even in these regions no certain indications of the presence of mica in a dike have yet been discovered. For the most expert miner, it is still substantially a mere guess whether paying mica is present or not. When present, there is often a distinct lead which the mica blocks follow, strung out along either the hanging or foot-wall of the dike, and in this case the excavations may be made through the somewhat softer country-rock instead of in the hard pegmatite. But this lead is often discontinuous, petering out into worthless trash or scrap; and it may, or may not, start afresh further on in remunerative quantities. Thus days may be lost in groping about for a new lead, and it has happened that the entire profits of a rich haul of mica have been consumed in this manner. Mines have been abandoned as exhausted, and yet when again worked by a subsequent owner have yielded plentiful returns. Nor are leads always present, for the mica often occurs bunched together in pockets, in great agglomerations of crystals, or even single crystals of large size.

The mica as it comes from the mines is in blocks which are theoretically short rhombic prisms, but practically are scarcely recognizable as such, having a very rough and uneven contour. They have a very perfect cleavage parallel to the base, and may be split into laminae thinner than the thinnest tissue paper, and these laminae form the familiar, transparent stove-panes and lamp chimneys. The exterior portions of these blocks are opaque, brittle, and worthless, presumably from the penetration of water, for mica soon decomposes when exposed to any considerable weathering. A thick layer of plates has therefore to be removed from either face of the block before any mica of commercial size or value is reached, and the sheets split from the remainder are surrounded by a wide margin of worthless material.

But the difficulties and losses of mica mining are far from being all enumerated. Even when occurring in blocks of commercial size, it is rendered valueless or comparatively so by one or more of a series of defects, which may be classed as: color, specks, ruling, ribbing, and wedge-formation. Color is a defect only for certain uses, as for stove glazing, and, in ground mica, for decorative purposes. The color of mica may be anything from black, dark-green, or wine-color, to yellow and pure white or, rather, colorless; the former kinds being useful principally for electric and the latter for glazing purposes. The color of mica is dependent on its composition, and both together are the main guides to its value, independently of other defects.

A great variety of minerals known to the geologist, all of more or less indefinite composition, are classed as mica. Physically, all have the well-known micaceous lustre and cleavage; and chemically, all are substantially compound silicates of aluminum and of some other base or bases, such as soda, potash, lithia, lime, magnesia, iron, manganese, etc. For present purposes, we may roughly classify the three main commercial varities as white or potash mica ("muscovite"); yellow or magnesia mica ("phlogopite"); and black or iron mica ("biotite"); but it is not to be understood that these form hard and fast lines, for they shade insensibly into each other. The last is much the commonest of the three, and indeed most colored micas owe their tints to iron, which is the all but universal coloring agent, and biotite is found in all colors between light yellow-green, smoky brown, and black. The potash mica is too hard and brittle for most electrical uses, but well adapted for glazing and flour. The yellow mica (which includes the "amber mica" of the trade) is fairly well adapted and much used for both purposes. The black mica is unavailable for glazing and flour, but is generally excellent for electric purposes, when not marred by specks and streaks, to which it is peculiarly subject, and which absolutely destroy its usefulness. That which is most in repute for the last-named use, however, is a dark wine-colored or ruby variety from India, called by the trade name "India mica," though the color is not confined to India, and India produces other mica. The green micas, on the contrary are rather too hard for electrical uses and a bad color for glazing, as it happens that a greenish tinge sticks to them and is perceptible even in thin sheets; and again, it has been found unfortunately that when ground they give a flour deficient in lustre, so as to be unfitted for this purpose; they are therefore, of inferior value.

Coming now to the defects properly so called, that of specks and streaks is one to which biotite is peculiarly subject. It some times occurs literally pied with black dots, consisting in general of black oxide of iron or garnet, and when even a few of these are present its commercial value is destroyed, because such mica when used as an insulator is peculiarly liable to puncture, the specks forming practically short circuits for the electric current. The same is true of streaks, which are sometimes turned to red rust. Strange freaks in the arrangement of the streaks have been observed, as for instance where a block was half white and half black, the margins being sharply defined by a straight line running through the middle of each sheet; or again, where the streaks ran parallel to one or both edges of the block, marking off the sheets like a checkerboard. The causes for these strange formations, as well as for the following similar ones, are entirely problematic.

Some otherwise excellent mica is found to be ruled or cut, as it were, with a series of perfectly straight lines, parallel to one side of the crystal, so that on being split the mica falls immediately into strips. The defect may be confined to the sides of the block, or extend entirely across, and sometimes the block is "double-ruled" so as to break up into small lozenges. Such mica is of course perfectly good as scrap, though its value as sheet mica be destroyed. Or again, instead of being striped or ruled, the mica is often deeply ribbed or corrugated parallel to the adjacent edges of the crystal, so as to give the appearance of the letter A (or rather V) whence it is termed "A-mica." As the ribbed portion has to be cut away in sheet, such mica is also unprofitable, unless the blocks be large. Wedge-mica is that in which the block is thicker at one end than the other, the laminae partaking in the unevenness. Such blocks are wholly worthless except as scrap

The reader will doubtless now begin to understand why mica is high-priced. It is not at all that it is a rare mineral, like gold, silver, uranium, etc., but because of the hazards and uncertainties of mining it, and the extraordinary proportion of waste between the rough block and the finished product. But all is not yet told, for even after all else is allowed for, the somewhat irregular sheet of good material must be further diminished in size by cutting or trimming. Electric mica is now generally "thumb-trimmed," but nearly all mica mined in the United States for glazing purposes is still cut into rectangular shape before leaving the mine; and thus nearly one-half of the good portion goes to the scrap heap. Finally, if, as often happens, the square plates of cut mica are again cut up into other shapes, another large fraction of the material is wasted at the point of use.

Summing up the various sources of loss, it may be estimated (in the case of North Carolina) that the cut mica, as it reaches the market, is not more than one-thirtieth to one-one-hundredth part of the mica mined, and as a rule not more than one-five-thousandth to one-ten-thousandth part of the rock excavated.

Having thus obtained a general idea of the character of mica in its native state, let us glance briefly at the history of the industry before considering its present status in the United States. That mica was mined and utilized by the nations of antiquity for decorative and other purposes is a matter which need not here interest us. Of more importance is the fact that it was well-known to and highly prized by the prehistoric races of the Western continent, as it is evident from the finding of mica plates and ornaments in the tombs and mounds of the mound builders hundreds and perhaps thousands of miles from its place of origin,—if, as now supposed, all this mica was exported from a single centre in North Carolina. Here it was that, in 1869, under the shadow of Mount Mitchell (the highest point east of the Rockies), in exploring one of their mysterious ancient shafts in search of antiquities or what-not, their real object was rediscovered, and an archaeological problem was solved and a vast new source of wealth created at a single stroke. Previous to that time the entire supply of mica was drawn from southern New Hampshire, and a large part of the American product is still from that State.*

Upon the discovery of mica in North Carolina, however, a rush for lands ensued which paralleled on a small scale the gold fever of twenty years previous, and in fact even today the valuable mineral may be said to play the same part among the natives of Mitchell and Yancey counties as gold does in the placer districts. The output quickly outstripped that of New Hampshire both in quality and quantity, and the leadership has been maintained, for North Carolina still produces about three-fourths of the country's output in value. For many years mica mining in North Carolina continued to be a very lucrative occupation, and mica lands changed hands at fabulous rates; but the decline of the 80's, and the increasing competition of foreign mica, brought the industry down to a more commonplace basis. At least a dozen other States have from time to time contributed in a small way to the American product of mica, but only two are of consequence, to wit, the Black Hills region of South Dakota and Wyoming, and the Cribbensville district of New Mexico; but even their contribution is trifling. Practically the whole American product continues to be mined in southern New Hampshire and the back counties of North Carolina, and must continue to be so until some new and better region shall be discovered. Until about twenty years ago these two States were substantially the mistresses, not simply of the native market, but of the world's as well, for Europe has no mica of her own. But in the early 80's two new countries—Canada and India—almost simultaneously appeared as producers, and their output has grown annually with such rapidity as, in the case of one of them at least, to overshadow and even to threaten the existence of the industry in the United States.

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* The Ruggles mine at Grafton, which has been in continuous operation since 1803, has produced $8,000,000 worth of mica, and at one time produced four-fifths of the total requirement of the United States.

The Canada mica comes principally from Ottawa county in Quebec, though some is also mined in Perth and Renfrew counties in Ontario, and the mines are chiefly the outcome and legacy of the "phosphate boom" of the 80's, during which many valuable deposits of mica were discovered in the soft apatite. Here lies at least part of the secret of the cheapness of Canadian mica, for apatite is far more easily mined than the flinty matrices of the pegmatite dikes. The increasing demand of recent years for mica for electrical purposes has caused great development of the mines, modern machinery has been installed, and the production of Canada now equals in value and exceeds in quantity that of the United States. This mica is deficient in transparency and in size, but is considered very good for electrical purposes.

Mica has been mined and used in India from an indefinite period, but the development of the mines by Europeans has been contemporaneous with that of Canada and of the electrical industries. Until very recently the only source of Indian mica was in the province of Bengal, where very large and rich mines were discovered, centering mainly in the Hazaribagh district, where more than 6,000 men and an indefinite number of women are employed. It is the ruby mica of this region that has made its reputation as "India mica" in the United States and Europe. Within the last four or five years, however, new districts have been opened up, in particular in the Bombay presidency and in the Nellore district of Madras, and these being nearer the coast are more favorably situated for export. Export from these regions has, in fact, grown with great rapidity. Enormous sheets are said to have been found at Nellore, one being reported as measuring five feet across.

The secret of the cheapness of the Indian mica and its threat to the western industry lies in four main advantages: the ease of working the mines, their richness in mica, the quality of the product, and the cheapness of labor. The ease of working lies in the fact that the rock matrix is so decayed that it is easily cut away, and the mica is so abundant that scarcely any of the mines are worked beyond a depth of 200 feet. The product is moreover considered better adapted for electrical purposes than other mica by reason of its softness and pliability. But the greatest advantage lies in the cheapness of native labor used in working, the men receiving but 3 annas* per day and the women half that amount. Yet there are disadvantages, too, as for instance the distance of the mines (35 to 70 miles) from rail transportation, and the climate, which makes the region untenable for Europeans during the rainy season, so that the mines can be worked only nine or ten months of the year; a further disadvantage is the small sizes of the Bengal mica.

The value of *sheet* mica produced annually by India is far in excess of that produced either by the United States or Canada, and the quantity would bear a still greater disproportion, and moreover the production is on the increase. By values we may reckon the production at the present time about as follows: India one-half, and the United States and Canada each about one-fourth. Of this world's production it is interesting to note that the United States consumes *more than one-half*, including all its own product, the bulk of that from Canada, and a large fraction of the Indian mica, the amounts of Canadian and Indian mica imported each being about equal to the home product. The remaining portion of the Indian mica goes almost all to England, and is there partially reshipped to Germany and France, the only other users of consequence.

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* The anna is 1-16 of a rupee, and its equivalent in gold varies widely with the price of silver; at the present time, with the rupee equal to about 1 s. 4 d., 3 annas would be about 3 d. or 6 cents.

In considering the status and prospect of the mica industry the uses of mica form a very important element. The two principal uses of mica are, as previously mentioned, in the stove and lamp trade, and in the electrical field. Prior to 1880, the former was substantially its sole use, and owing to the great decrease in the use of stoves in recent years, caused by the introduction of improved methods of heating, both the demand for and the value of mica experienced a rapid decline. By the beginning of the last decade, and especially during the years of commercial depression, owing partly to this cause and partly to the great increase in imports, the industry had become almost extinct in the United States; but since 1895 it has more than regained the lost ground. The causes for this sudden revival are two: the new use for mica, now far more important than the old one ever was—as an electric insulator; and the appearance of a new branch of the mica industry—the manufacture of mica flour.

To those unfamiliar with the matters under discussion, two questions will here present themselves, to wit: Why is mica of such importance as an insulator? and, what *is* mica flour? Let us consider each of these briefly and in order.

Mica is or may be employed in almost all forms of electrical apparatus, being one of the best insulators known, and in practical all-round use perhaps the very best. In resistance to the electric current and to puncture by spark it is about equal to glass, and stands therefore nearly at the head of the list, while its toughness, flexibility, infusibility, and perfect impregnability to moisture (all qualities of great importance in an insulator), and the extremely thin leaves in which it may be obtained, make it absolutely without a rival for the purposes for which it is used. While suitable for almost all kinds of electrical work, it finds its chief use in the commutators of dynamos and motors, in which service it has no substitute; and as all direct-current machinery must have commutators, and the use of such machinery is constantly on the increase, it can be seen that the increasing use of mica is inevitable. Its high price has naturally caused a substitute to be much sought after, but none has been found, and it seems unlikely that any will be found, animal and vegetable products being all barred by their susceptibility to heat. Enormous quantities of small electric forms, such as commutator segments for fan-motors, washers, small plates for the interior of cut-out boxes and fuse-plugs, and the like, are now punched from what was heretofore considered scrap mica and was substantially valueless. Other waste pieces of mica are cemented by shellac into large sheets of uniform thickness, called "micanite,"—

also used to some extent for commutators,—or pressed into the forms of tubes for covering armature wires or other irregular shapes.

But another important industry has arisen almost simultaneously with the electrical industry—that of mica flour. In 1870 a patent was issued to Frederick Beck for a process of coating wall-paper and other surfaces with a mixture of ground mica and transparent varnish. When so applied to surfaces mica has a silvery lustre and sparkle which is not simply equal to that of metal, but has the vast additional advantage that its lustre can never fade or tarnish with age, as all metals must do sooner or later. Moreover, the great cheapness of the mica powder or flour compared with that of metal dust caused it to supersede the latter entirely as an ingredient in wall-paper colors; processes for gilding and coloring it having been invented. At the present time almost all of the cheaper wall-papers are decorated with large quantities of mica paints, while the finely tinted grades are used even in the higher-priced papers. Yet while mica flour has been a staple commodity in the market since about 1890, it is only within the past five years that the great development has taken place, the production of mica flour rising from less than 600 tons in 1896 to 7,000 tons in 1899. The value of scrap mica rose from nothing to $17 per ton, and as many of the mines had large dumps of scrap mica, they were able to realize considerable sums by its sale. The production of scrap mica increased, and in New Hampshire many mica mines were operated for scrap alone, so that the price of scrap soon fell again to about $6 or $7 a ton, where it still is. But the flour industry continues to grow, though still confined wholly to the United States.

From the above brief review, it may be surmised that though encouraged by the two new sources of demand for mica products, now on the increase, the American mica industry is so threatened from without by foreign competition that its future stability is seriously in doubt; and this surmise is in part correct. It is only a formidable protective tariff (amounting practically to prohibition as to scrap and flour mica), one may say, that prevents its extinction; take that away, and it would be immedately swamped by the flood of foreign imports; for how can the United States compete with the pauper labor of Asia, paid at six cents a day? Such a conclusion, however, is apt to be erroneous, as has often been found in the case of other industries, and as a more thorough knowledge of the conditions well shows in this case also.

The fact of the matter is that the whole rich mining region of North Carolina has been strangely overlooked by northern capital, and the spirit of enterprise which has swept over the country during the last five years and brought it such unparalleled prosperity has passed that section undeservedly by. There the crude unlettered mountaineer still goes forth with hand-bit and hammer to "hog" the mine, it may be, for a royalty of 15 or 20 per cent. to the owner; or at best, a dozen join together in their slow and painful operations of drilling and blasting, a rough screen-reel is constructed for freeing the mica from dirt, and the blocks are split by hand and cut one by one with a pair of shears and a templet in a neighboring shed; in short, mica mining in North Carolina is exactly where it was thirty years ago. The backwoodsman has intelligence, but nothing like enterprise; his labors are limited to the needs of the day and hour. The streams still glide over the gleaming crags unharnessed; the timber forests remained unused.

It is useless to say that the power drill cannot be advantageously applied to mica mining; that has too much the air of the philosophers who proved the earth was flat, that heavy bodies fall faster than light ones, etc. Experience of the New Hampshire operators as well as of the Canada mines has proved the contrary, and in each case the introduction of power has been followed by a large increase of output.

There is room for immense improvement and development in the mica region by a judicious expenditure of capital. There need be no fears of North Carolina being unable to hold her own against either India or Canada, for the simple reason that she has a superior grade of mica, and all that it is needed is economical methods of production. She has both first quality and large sizes, and that is a boast which neither Canada nor India, nor any other region in general, can boast She is within easy reach of all the great mica markets; she too has plenty of cheap, but intelligent labor; she can mine for sheet and scrap simultaneously; and she has abundant water powers in the immediate mining district, and coal not far distant. When as much money and brains have been employed in introducing modern methods there as have been employed in New England, it will be found that the North Carolina mica has no more to fear from India mica than the New England and Lancashire cotton mills have to fear from the Indian spindle and distaff; and this is no doubt true to some extent of New Hampshire also.

AIDS IN TAKING THE MACHINE-SHOP INVENTORY.

By Hugo Diemer.

IN an establishment of sufficient magnitude to justify the employment of a full and capable clerical force to handle the cost and stores department, stock-taking is not as formidable a matter as in smaller concerns; but in many manufacturing establishments, the taking of an inventory is looked forward to as the most onerous task of the year. It is frequently months after the date on which the work is begun before the final results are announced.

In factories where systems of cost and stores accounting are used similar in principle to the excellent methods described by the late J. Slater Lewis in his comprehensive work,* it is feasible to have the books closed and inventories taken as often as monthly. The question of how extensive a factory must be in order to justify the employment of such a full clerical force is naturally one which depends upon the complexity of the manufacturing processes and also upon the margin of profit. It is, however, true, that the complete cost analysis revealed by a full clerical force may in itself be the very means of increasing the margin of profit. I had occasion to be shown the cost and stores systems of a factory whose output amounted to about $250,000 of annual sales. The number of persons doing clerical work in the establishment amounted to about 10 per cent. numerically of the entire working force of the company, and it is fair to assume that their salaries represented an equal percentage of the total wages expenditure. At first sight this clerical force seemed disproportionately large. Yet I was assured by officials of the company that since the introduction of this system they were able to adjust their prices with a feeling of confidence that they had never before possessed. The books are closed and a complete report of the company's business is rendered to the directors on the 10th of each month for all business done during the preceding month. The company has been able to meet the prices of all competitors, to maintain a high degree of mechanical excellence, and to declare a monthly dividend of 1 per cent. for more than two years. The successful application of a complete cost and stores system to an establishment of this size, employing only about one hundred men, has strengthened my conviction that a more general adoption of these methods in smaller factories will surely come, and will be accompanied by more general industrial satisfaction on the part of both employers and employed.

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* The Commercial Organisation of the Factory.

There are, however, many factories that are not quite prepared to go so fully, or, as they would put it "plunge so deeply" into shop-accounting systems. But with even an office force of minimum size the matter of inventory taking may be simplified by the use of properly arranged card systems.

In general the inventory may be divided into three broad headings:

1:—Plant.

2:—Stores.

3:—Finished and Partially Finished Product.

The items coming under the heading of Plant, if properly recorded, can be inventoried in a very short time. Under this heading will be included Real Estate, Buildings, Power-Generating Apparatus, Transmission Apparatus, Piping, Wiring, Fixtures, Machinery, Contents of Tool Room, Patterns and Drawings.

It is advisable to keep a separate card on which to keep record of each single item included in the above sub-divisions with the exception of Contents of Tool Room, Transmission Apparatus (Shafts, Belts, Pulleys, etc.), Piping and Wiring. A card suitable for those Plant items which will have a distinct card for their record is shown below.

Item No. *125.* Name *Universal Milling Machine.*
Size No *1½.* Location *Section "A."*
No on Article *29.* Date Purchased *6/25/99.*
From *E. S. & E. Co.* Cost *$650.00.*

Date.	Last Inventory Value.	Repairs.			Depreciation.		Present Inventory Value.
		Date.	Nature.	Amount.	Per cent.	Amount.	
Jan. 1. 1900	*650.00*				*10% 6 m.*	*32 50*	*617.50*
Jan. 1. 1901	*617.50*				*" 1 yr*	*61 75*	*555.75*

FIGURE I. INVENTORY CARD FOR PLANT ITEMS.

The number in the upper left-hand corner of the card after the words "Item No." is merely the number of the card itself, and is inserted in order that an alphabetical index may be kept. Thus in the alphabetical index we will find under "M" "Milling Machines—Cards Nos. 126, 228, 329." The fixing of the location of the article and the number painted or stamped upon it are further identifying checks. Where the factory is divided into "Sections," the letter or number of the section is usually sufficient to locate the piece.

The proper percentage of depreciation to be used is a matter which has been discussed at length by various writers. Experiments have been made to determine the average life of various items. It is evident, however, that the length of life and rapidity of deterioration of machinery and transmission apparatus will vary widely. Where trustworthy data, based upon a number of years of observation, are not at hand, it has been customary to allow a general depreciation of 10 per cent. per annum on all machinery. On belting and transmission apparatus in general a slightly larger depreciation is sometimes charged, varying according to the service. Buildings kept in good repair are often charged with a very low percentage of depreciation.

Figure 2 shows a form of card suitable for the record of articles of which there is a considerable number of one kind, and which do not require individual record, such as small tools, shafting, etc.

Item No. *327.* Name *Flat Bastard Files.*
Size *8″* Location *Drawer 89, Tool Room.*

No. on Hand.	Value.	No. Added.	Cost.	Repairs.		Depreciation.	Present Inventory Value
				Date.	Amount.	.... %	
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....

FIGURE 2. INVENTORY CARD FOR SMALL ARTICLES.

It is very similar to the card shown in Figure 1, but will necessarily be a longer card, requiring a deeper cabinet for its filing, because of the frequent additions necessary during the year. For the small items covered by the card of Figure 2, it is best to be more explicit as to location. In the example given the drawer number in the tool room is stated. In the case of transmission apparatus we might say "East side of Section B", or some similar brief location. The record of small tools may be further refined by stamping numbers on files, cutting tools, etc., and recording each small tool individually on the large card of Figure 2. This system has been applied to the shops of a technical college and may possibly be found useful in some factories. It will be seen that all the cards of form shown in Figures 1 and 2 can be easily kept figured up to date, and that consequently items coming under the general heading "Plant" can be very easily inventoried at any time.

The real value of patterns and drawings as an asset is a matter in regard to which there is considerable difference of opinion. Special drawings and patterns are charged to the particular order for which they are made, and these cannot be considered of any value excepting as scrap. On the other hand, standard patterns and drawings have a real value which should be subject to a considerable depreciation. Where the value of standard drawings and patterns is not calculated for each piece, but all work on such standard patterns and drawings is charged to a standing order number, the total cost of all new standard patterns and drawings for the year is given by the standing order, and this total added to the properly depreciated value of the previous year gives the current value. This method of course does not assign a definite price to each individual pattern and drawing. Where record is kept of the cost of individual drawings and patterns, distinct cards for each piece may be used similar to the forms shown. These forms will be useful in recording the proper location of patterns in racks, and additional columns may be added showing how often and on what orders the standard patterns and drawings have been used.

Referring to the second general subdivision, namely Stores, all systems of mathematical record need to be checked annually by an actual count. If this checking up is all done at one time, the store keeper should be furnished additional help at that time. A form of card which enables the store keeper to see at once the number of pieces of any article he has on hand and the number he needs for orders in hand is shown in Figure 3. If the checking up by actual count, to verify the amount on hand as shown by the cards, is practiced continuously, the card records are available for inventory-taking at very short notice. The valuing of goods is facilitated by having on hand lists of standard screws, etc., with the prevalent net price per hundred inserted in ink in the printed lists. Such lists accompanied

Item No *625.* Name *Hex. Hd. Cap Screws.*
Size *3/8'' x 2''.* Location *Drawer 267, Store Room "A."*

1. On Hand at Last Count.	2. Received.		3 (1+2)	4. Needed for Orders.*		5. Excess or Shortage. (3—4)	6. Drawn on Orders.		7. On Hand. (3—7)
	Date.	No.		Order No.	No. Req'd		Order No. and Date.	No Drawn	
10/1 321	*10/20/1901*	*00*	*421*	*Brotfor'd*	*212*		*B621 10/23*	*48*	
				~~*B 621*~~	~~*48*~~		*C273 10/25*	*32*	
				C 273	*64*		*B622 10/27*	*12*	
				B 622	*24*				
321		*100*	*421*		*300*	*121*		*92*	*329*
11/1 329				*Brotfor'd*	*300*				

*NOTE.—As orders are completed they are cancelled in Column 4. When card is balanced a line is ruled across the card and balance as shown in Column 7 is transferred to Column 1.

FIGURE 3. CARD FOR STORES ON HAND AND NEEDED FOR ORDERS.

by a slide rule will be found to be time-saving devices. A judicious use of the slide rule would relieve cost work of a great deal of drudgery, but there is a wide-spread feeling regarding its use which is best expressed by the following remark made by a shop foreman concerning one of the engineering staff: "He's one of them 'slide-rule' fellers—too technical to be practical". Not wishing to fall in his estimation I did not apprise him of the fact that I made daily use of the simple little instrument in cost-department work.

It is apparent at once that in a store room containing from five to ten thousand items it will be about all that one competent clerk can do to enter daily from bills of material of new orders the number of items required for orders, and to check off on the cards the number of items drawn. The preparation of several thousand cards is in itself no small task. The officials of a company have been known to acquiesce willingly in the erection of proper racks and drawers in a store room, and to employ willingly more "store-room boys," but to hesitate when confronted by the expense of a card accounting system. The case is perfectly analogous to that of an inefficient power plant whose inefficiency is not apparent on account of lack of engineering instruments and engineering ability, where, instead of raising the efficiency of the system by bettering it, more generating apparatus of equally low efficiency is added, thus continuing the loss on a larger scale. The principles of good engineering find opportunity for their application in the store room as well as in the power plant and designing room.

Stationery and printed matter will be included under the heading of Stores. A system for recording stationery forms and costs consists of stout envelopes bearing the numbers of the forms, copies of the forms themselves being kept inside the envelopes. The dates of ordering, amounts ordered, the name of the printer, and the prices paid, are recorded on the envelope. The envelopes are then put into cases such as are ordinarily used for the filing of vouchers or documents. With the aid of this index, which is kept in the purchasing department. stationery and printed matter can be quickly inventoried. It is just to consider forms in current use as worth what they cost. The intrinsic value of catalogues and printed matter may be almost a negligible quantity when compared to their cost. In establishing inventory values, however, the sane view (and that most generally taken) is to consider the value of goods as what they would be worth to a company engaging in the same business on the same premises, and not the figures that articles would bring if sold at a forced sale. For this reason it is customary to attach a value to factory fixtures, special tools, and foundations, as these are all essentially part of the plant.

The accuracy of the inventory prices attached to the third general division, namely Finished and Unfinished Parts, depends upon the cost-calculating system employed. It might appear that a good way to obtain approximately the cost of unfinished parts would be to close up to a certain date all time-and-material records on all unfinished orders. As a rule, such a procedure would interfere very greatly with the continuousness of work by the time and cost clerks. A far more satisfactory way is to build up costs of individual parts, preserving them on cards arranged according to pattern numbers. With these costs as precedents, values of unfinished parts can be closely approximated.

The introduction of card systems similar to those suggested, and the employment of a few really competent clerks to handle the cost and stores systems, will make the monthly closing of factory accounts possible even in comparatively small establishments, and in most cases the advantages gained will more than compensate for the expense entailed.

EDITORIAL COMMENT

THE Isthmian Canal remains easily the most important material question before the commercial world—for it is of world importance, and of foremost importance to the great maritime nations almost in direct proportion to their merchant tonnage. One of the curious phases of the matter is that shipping interests have taken so little apparent part in the debate, for the most important question of all is, what will be the actual service of the completed waterway to the sea carrying trade? If the Nicaragua Canal when finished will be so difficult of navigation, so menaced with risk of accident or delay, so embarassed by the necessity of contant maintenance and repair operations, that insurance and pilotage rates become burdensome, and masters refuse to attempt the passage under any ordinary conditions, the world will be no better for the enormous expenditure and the United States will be millions the worse in pocket and immeasurably humiliated in influence and prestige. Glory to the United States does not lie in the flag fluttering over the canal, but in the commerce streaming safely through it. And that shipping would ever take freely to the Nicaragua Canal, completed as planned or on any plans which are possible to the route, we do not believe. The long stretches of canal section and canalised river, the difficult and relatively sharp curvature, the extension of the time of semi-dangerous navigation to so long a period as thirty-three hours, would inevitably shut out a great proportion of the possible patronage and would hamper the remainder so far as greatly to diminish the benefits of the canal. The route could not hope to compete for any traffic which could be alternatively routed via Suez, nor for any which could afford the time of passage via the Straits of Magellan.

* * *

It is most extraordinary that the disputants, so far as they appreciate or acknowledge at all that any economic considerations are involved, seem to think of nothing but the elements of construction, whereas the whole question of construction is entirely minor to questions of operation, maintenance, and above all, utilisation. Mr. Charles Paine, writing in THE ENGINEERING MAGAZINE in February, 1900, laid down the proposition that the serviceableness of any ship canal is inversely as the square of its length. Mr. George S. Morison, whom engineers generally will doubtless regard as by far the safest engineering authority on the Walker Commission, expresses practically the same conclusion, stating that the projected Nicaragua line, involving 2.3 times the length of steaming in actual canal sections which would be required by the Panama route, would carry five times the risk of detention, even supposing (which is extremely far from being the case) that navigation would be as easy by the Nicaragua Canal as it would be by the Panama. The greater ease, safety, and celerity of the Panama passage would make that route preferable if it cost double as much to construct as the Nicaragua. And while prophecy is a very uncertain avocation, we venture the prediction that if the Nicaragua scheme be unfortunately adopted, the United States will be making further and further appropriations for it long after double the money has been expended which would complete the Panama line. But to return to our point: the shipping interests, to whom it is infinitely more important that a canal should be navigable than that it should have been projected, surveyed, and dug wholly by American engineers, should make their influence felt. Campaigning for education is slow, particularly among politicians, but it does make some progress. The 102 congressmen who were willing to allow the President to negotiate for Panama as well as for Nicaragua, represent an element of saving sense which may yet protect their country from the most "un-American" of all acts—the building of a bungling, inefficient, unserviceable tool.

* * *

MR. GEORGE A. SOPER, in the *Medical News*, discusses in a most interesting way certain aspects of the Isthmian-Canal construction problem which, prior to the appearance of his article, had been curiously neglected. These are the sanitary conditions which must be dealt with both during construction and (again more important) throughout the operation of any canal across the Isthmus.

Mr. Soper notes the curious circumstances that, notwithstanding the radical influence which the question of liability to disease has upon the problem of labour—the greatest problem of all in the actual construction work—less than a page and a half of the Walker Commission's 263-page report is devoted to hygiene. This is hardly more space than General Abbot gave to the topic in his short but powerful article in this Magazine last month.

It is possible only to refer very briefly to Mr. Soper's most important conclusions, which are ably sustained by a thorough comparative review of the climatic and hygienic conditions, so far as they are known, along the two routes.

These conclusions are: that both routes pass through a country which is extremely unfavourable to health, the rainfall conditions in Nicaragua making it distinctly the more sickly region; that soil, topography, and the nature of the work to be done favour Panama, as the employment of fewer men in more concentrated organisation would reduce the number of lives exposed and make protection easier; after construction, the difficulty of controlling health conditions along the line would be greater on the Nicaragua route, and the longer time needed for transit would expose passing vessels to nearly three times as great a risk of infection; the likelihood of the canal becoming a disease focus, (thus interfering with commerce by requiring quarantine at healthy ports against vessels using the canal) is much greater in the case of Nicaragua than in the case of Panama; lastly, whichever canal is selected, extraordinary care will be needed to maintain satisfactory health conditions during construction *and afterwards*, and plans for an efficient sanitary and medical department can not be made too soon.

* * *

MR. SIEBERT, reviewing our editorial introduction of his leader in this number, expresses his preference for a slight change in the second paragraph. In the summary of his own views, he would say "the general manager of most modern enterprises can not be successful without a certain amount of technical knowledge."

We gladly give place to Mr. Siebert's own phrasing of the concept here, for the underlying idea, we are sure, is identical in his mind and in ours. The word "engineer," however, Mr. Siebert doubtless understands in its strict Continental usage—as defining a certificated member of a distinct profession. We used it in the broader English sense of a man possessed of knowledge of a particular branch of technics—that is, engineering practice.

REVIEW OF THE BRITISH PRESS

Legislation and Electrical Progress.

The address of Mr. Percy Sellon before the Chamber of Commerce, published in the *Electrical Review* contains a very significant opinion as to the cause of the lack of progress of electrical development in Great Britain. As Mr. Sellon points out, there is every reason why Great Britain should have held the lead in the practical applications of electricity to which her preeminence in original research entitled her. The work of Faraday, Tyndall, and Joule, followed by the brilliant inventions and discoveries of Cooke, Wheatstone, and Thomson gave her a lead which other nations should have found it hard to overcome. Great Britain's free trade, her unparalleled manufacturing facilities, capital resources, and control of the world's markets all formed abundant reasons for the maintenance of her supremacy in this as in other branches of industry.

Instead of this possible high position in the electrical industry, we find that other countries have passed Great Britain in the race, and that at present she is in the position of gazing at her competitors and wondering why they have distanced her. As Mr. Sellon says: "We are both absolutely and relatively to the other leading communities of the world in serious arrear of the position to which we should have attained, having regard to the commercial traditions, free institutions, and highly organised industrial equipment of which we were the heirs when, less than a quarter of a century ago, the great developments of electrical science in the fields of telephony, lighting, traction, and power distribution, passed from the purely experimental stage into practical potentialities.

Various causes have been advanced to account for the present state of affairs. Among these are the early reckless speculation in electrical affairs, the commercial expansion of Germany and the United States, the unfavourable home labour conditions, and the general apathy of engineers and manufacturers. Nearly all of these causes however, have been at work in other countries as well, and without any such blighting effect as is claimed for them at home. Mr. Sellon examines each one of these points in detail and while admitting some of the effects attributed, he shows that they are entirely inadequate to explain the observed results so far as Great Britain is concerned. To maintain that the electrical progress in Great Britain is in arrear because the British electrical engineer is behind his rivals, is to reverse cause and effect, since the backward state of the electrical industry and of the electrical manufacturer are due to one and the same prime cause.

This prime cause, as Mr. Sellon clearly shows, is the fact that the legislature has applied to electrical science the principles of common ownership which, during the latter half of the last century have established an increasing hold on men's minds in England.

That there are certain functions of an industrial and engineering nature which properly devolve upon the municipality, every one will admit. Thus the protection of life and order, the maintenance and improvement of highways, the provision of open spaces for recreation, the control of education, provision for water supply and for sanitation, these and similar duties are most properly placed in the control of the municipality.

In 1870 the state bought out all the private telegraph interests for £10,000,000, and set up as monopolists in the art of transmitting intelligence by electrical means, and when the telephone appeared in 1877 the state laid violent hands upon it, with the result of making Great Britain the worst served country in the matter of telephony of any great industrial state. The Tramways Act of 1870 and the Electric Lighting Act of 1882 settled the maxim of industrial legislation that the community should have an option of expropriating any public enterprise after a certain term of years without a burdensome addition in respect of good will and compensation for prospective profits.

The result has indeed been an enormous acceleration in the pace of municipal enterprise, but this has not been attended with the development of British industries which would have followed the encouragement of individual operations. The whole question is well stated by Mr. Sellon when he says:

"It is a question of profound national importance whether the alluring end of common ownership with all its promises may not be too dearly bought at the cost of the extinction, inevitable, if gradual, of private enterprise; whether gigantic systems of local self-government with their accompaniment of petty officialdom controlling all matters of daily existence will make life better worth living for the majority than a social structure founded on greater liberty and reward of individual effort; whether this country's past industrial supremacy can be better maintained, in the light of the conditions of acute external competition which have arisen and are becoming yearly more severe, by increasingly transferring the mainsprings of its operation from individual to corporate activity; whether socio-industrial progress can be better achieved under the auspices of necessarily inelastic and inexpert organisations such as corporate bodies acting as trustees of others' funds, than by expert administration stimulated by the hope of personal gain."

Electric Traction on Railways.

It was to be expected that the inaugural address of Mr. W. E. Langdon before the Institution of Electrical Engineers would deal largely with the question of the application of electric traction to main-line railways, and this expectation was not disappointed.

That electric traction is generally bound to come, Mr. Langdon fully believes, and considered without regard to existing methods and conditions, few will differ from him. When, however, existing conditions are taken into consideration, the obstacles appear to be great.

"Every line of railway has its own mode of dealing with its traffic, and the character of the traffic is not the same on all lines. The only satisfactory way to prove the power of electricity to meet existing conditions is to impose upon it the work to be done. To do so on a suitably selected section of line would not be a great tax upon the resources of any one of our great railway companies, especially as it need not in any way, for the time being, derange the steam-worked traffic passing over that section of line.

"Now let us look at the subject from another point of view. Electricity is credited with the power of accomplishing greater speed at a less cost than steam. An impression is abroad that greater facilities for rapid transit between large centres of commerce are a necessity of the day. If it should transpire that electrical propulsion is inapplicable to main line traffic as a whole —a conclusion which few would, even at the present moment, accept—it will unquestionably lead to the establishment between the chief commercial centres, of high speed passenger electric traction on independent lines. Communication between Manchester and Liverpool has, so far, been met—and one would say, amply so—by three lines of railway, all running a good train service, yet the construction of an electric line on the mono-rail system has received Parliamentary sanction.

"Nothing could be more disastrous than that competition of such a character as, for instance, that thus initiated between Liverpool and Manchester should arise. Whatever success may attend competitive electrical enterprise in this respect must be, to some extent, prejudicial to the established systems. If the former should prove a pecuniary success, the reverse must be the condition of the latter. The capital invested in existing railways exceeds thirteen hundred million pounds. The wholesale depreciation of such a vast sum, the interest of which forms the income of numerous families and annuitants, would be little short of a national calamity. Naturally, were independent electric lines of railway to be established between the chief centres of commerce it would still leave a large mileage of the existing lines of railway unaffected by them, but is it from those parts of a railway system that the earnings come? The consequence must be, at the least, a decreased dividend, and probably in the end an enforced establishment on the older lines of a similar electric service between large towns.

"The work of the railway engineer is to construct railways; and if the opportunity arises he will not be deterred from doing so by any consideration of the injury his work may inflict upon existing interests. The way to prevent him from doing so is to make it clear that there is no profitable need for any such addition; and this can only be accomplished by the existing systems showing that they are prepared to avail themselves of the same means—to afford as far as possible the same facilities and advantages as are to be derived from independent electrically worked lines.

"Railways have to face the fact that electricity as a motive power is before them. That if it is not applied to the existing systems—if they do not elect to avail themselves of it, it will come independently, and in competition with existing interests.

"To attempt to approach the subject in a piecemeal fashion by dealing with a branch line here or there may be of service, but it can scarcely affect the main issue. While a small branch line is being converted, new lines between important centres will be constructed, and the passenger traffic between those centres will at least be split between the old and the new service. No one doubts the ability to apply electrical energy to branch lines, but many will doubt whether the traffic of a branch line can be so regulated as to form a continuous and remunerative service throughout the day. With main lines there can be no doubt of a regular demand, while most branch lines can with convenience be dealt with from the main line power station. Manifestly, however, if the trunk lines are eventually to be operated electrically, whatever may be done in relation to branch lines should be done with a view to harmonise with that system which will be ultimately employed on the main lines. I do not presume to indicate what that system may be—whether alternating or direct current—but it is clear that for main lines an overhead electrical service is inadmissible; and equally, to my mind, is a rigid or semi-rigid rate of speed. With a line carrying one class of traffic this latter question may not be so important, but on lines carrying a mixed traffic this cannot be so, for the power to vary the speed is a factor which must have an important bearing upon the working of the line. The speed, subject to a maximum limit, must be in the hands of the driver."

The preceding considerations bring up an economic problem which, while not new on a smaller scale, is doubtless destined to become more and more important and correspondingly difficult of treatment.

Are existing industries and investments to act as a bar to the development of new methods simply because of the upheaval which the change would cause? The advent of steam railways destroyed the stage-coach business, and small as this was compared with the present railway interests, the principle involved is the same. Because an industry has remained undisturbed in the possession of a certain field for many years does it thereby acquire a monopoly which is to bar all progress in rival methods of a new and revolutionary nature? There has been some discussion as to the position which the capital account of a business should hold, some contending that it is an asset, others that it is a liability, while others more frankly, and probably more correctly, have regarded it in the nature of a gambling stake. In private affairs a man risks his capital in a business enterprise, fully aware that some rival invention or new discovery may render the venture worthless, and there appears to be no good reason why the same rule should not hold in the case of corporations or in great aggregates of corporations. Already such a point has been raised in connection with the possible conflict between wireless telegraphy across the Atlantic in competition with the interests of submarine cable companies, and while this is a more or less remote rivalry, the interests involved are enormous.

The question bears a striking similarity to that of the depreciation and scrapping of obsolete machinery, which while in good working order can no longer be profitably used in competition with more modern devices. It will not do to assume that a plant can be carried along as a full representation of the invested capital merely by keeping it in good working condition on the basis on which it was erected and equipped. If it is not kept thoroughly up to date it is a most deceptive asset. The same is true of an industry based upon engineering operations.

It is practically safe to assume that sooner or later it will be entirely superseded, and that it should not only earn a profit on the original investment, but that it should also provide a sinking fund for the redemption of the original capital, or for the replacement of the old plant by the new. Such replacements are coming more frequently than the most radical have dreamed in the past, and that too upon an enormously increased scale, while the peaceful commercial solution of the problem is by no means in sight.

The War Office Motor Trials.

More than two years ago comment was editorially made in these columns upon the vast advantage which would have followed the use of motor vehicles instead of mules for hauling artillery and supply trains in South Africa. Since then the War Office has decided to investigate the subject, the matter having been placed in the hands of a committee on mechanical transport, and the results may be productive of successful applications. From a review of the work of this committee in several recent issues of *Engineering* we make some abstracts showing the progress which has thus far been made:

In order to obtain practical and trustworthy information upon the subject, it was decided to secure the assistance of the manufacturers of self-propelled vehicles, and with that view it was decided to offer three fairly substantial prizes for "the three self-propelled lorries which shall be adjudged, after a series of trials to be carried out by the War Office Committee on Mechanical Transport, to be the best suited for military requirements.

Eleven entries were made in response to the fully detailed set of official regulations which had been issued last summer, but of these only five actually took part in the trials, and of these but one was propelled by an internal combustion motor, that of Messrs. G. F. Milnes & Co., the others, by Messrs. Edwin Foden, Sons & Co., Straker Steam Vehicle Company, and by the Thornycroft Steam Wagon Company, all being propelled by steam.

The detailed description of the several machines may be found in the reports of the trials referred to above. All the steam vehicles were provided with compound engines the Foden vehicle being equipped with a horizontal multitubular boiler, while the Straker and the Thornycroft vehicles were provided with water-tube boilers. The vehicle by Milnes & Co. was practically a Daimler lorry, provided with a four-cylinder hydrocarbon engine of the Daimler type, and furnished with the Cannstatt system of transmission gearing. One of the Thornycroft vehicles was equipped with a winding drum and 100 yards of wire rope, for use either in pulling itself out of a hole or for extricating its trailer in case of need.

According to the requirements the net load was to be 5 tons, of which 3 tons was to be carried on the lorry itself and 2 tons on a trailer, these weights being exclusive of fuel and water, all of which must be carried on the lorry.

The requirements for military service are naturally different from those demanded for commercial service. Thus speed is of secondary importance, much more weight being attached to the ability to traverse rough and difficult ground, while the distance which can be covered with the fuel and water carried is naturally most important. With these requirements must be united great strength and substantial construction to insure freedom from breakdowns, while at the same time excessive weight is objectionable.

The trials, while severe, were none too much so when it is considered that the vehicles would certainly have to meet similar conditions in military service. On the road, of course there was little or no difficulty, even on steep hills, and in the brake tests there was every evidence that the designers had met the requirements very fully. On the rough country tests, however, the real conditions of a campaign became more apparent, and the difficulties began to appear. The Foden vehicle, which had made a most excellent showing, came to grief in a ditch, while the Thornycroft, after successfully traversing some very soft ground, and also hauling its trailer up an ascent by use of the winding drum, finally had to be extricated by the aid of a convenient traction engine.

The trials revealed a number of weak points about the engines, details which will doubtless be remedied after these trying experiences, but altogether the results of the trials were rather encouraging. It was hardly to be expected that vehicles designed primarily for commercial road service should meet fully to requirements for military transport, and the wonder is that they did so well as they did.

In summing up, we can hardly do better than quote from the report in *Engineering,* since it will probably be some time before the official reports are made public. Our contemporary says:

"Until the reports of the official observers—two of whom were on each vehicle—are made public, it would be premature to enter into details of the various competitions; for it is obvious that a considerable number of observers would be needed to keep all the wagons under observation during the many days over which the trials extended. It may, however, be safely said that the various tests have shown pretty conclusively that a self-propelled motor can be produced which would be of great use during the ordinary work of a campaign. Perhaps the Foden vehicle showed to most advantage on average roads. It made, on the whole, the best speeds on the long runs; though extra speed, we believe, is not considered, by the military authorities, a very important feature for these wagons after a certain moderate rate of travel has been attained. The low consumption of water and fuel which is reported of the Foden wagon may have been due either to the locomotive type of boiler, or to her feed-heater device, which also enabled a certain amount of exhaust steam to be condensed and recovered to use over again. We believe a filter was fitted to intercept grease. The chimney gases of the Foden boiler were of a lower temperature than those of some of the competing vehicles to judge by the state of the paint, and also from the fact that the exhaust was delivered from the chimney in very visable clouds, whilst the exhaust steam of other wagons was apparently superheated, as it was quite invisible.

"Thornycroft 'No. 6' is practically the standard pattern of the Thornycroft Steam Wagon Company's vehicle of this type. Thornycroft 'No. 7' was disappointing, considering the great things that had been expected of it. But it must be remembered it was entirely a new design, and the makers had not had an opportunity of trying it previously to correct the many little defects in detail that are sure to arise with experimental work. There was one feature about it which should prove to be a distinct success. That was the winding arrangement by which the power of the main engines can be utilised for pulling the vehicle out of a bog. The way in which the wheels of a traction engine will revolve in one place, merely sinking further and further into soft ground—excavating, in fact, a hole in which to bury the vehicle—is well known to many who have had such an unfortunate experience. Although the traction engine had to be called into use on the last day's trials, it is quite possible, had the ground been a little firmer, 'No. 7' might have wound itself out without assistance.

"So far as the respective advantages of the vehicles for military purposes are concerned, only military men can judge, and the awards of the committee of officers will be looked forward to with interest. It is to be hoped the full report will be made public."

Range Finders.

The Spanish-American war showed the necessity for some more satisfactory and reliable method of measuring range distances than was there available, and hence the paper of Professor George Forbes before the Society of Arts, printed in the *Journal* of the society, is of interest, discussing, as it does the principles upon which such instruments are necessarily based.

As Professor Forbes says, all methods of optically measuring the distance of an inaccessible object depend upon using a base of known length, measured either on the ground or else as a part of the instrument. For measurements on land a long base may be chosen and a theodolite or similar accurate instrument placed at the ends and very precise results obtained. For use in warfare, however, the instrument must contain all within itself, be capable of giving direct readings without computation, and be light and portable.

The conditions permit the use of only a short base, but with care in design and construction there is no reason why excellent results may not be obtained. The foundation of the present improved instruments is one by Adie, which consisted essentially of a base bar 36 inches long with four mirrors at 45 to the base, and a telescope in which two superposed pictures are seen, one picture being produced by reflection from the mirrors at one end of the base, the other picture from the other end. When the mirrors are parallel the images are seen double, but by slightly moving one of the mirrors they may be made to coincide, and the angle through which the mirror must be moved tells the distance.

This instrument was bulky and heavy, and the slightest variation in adjustment introduced serious errors, but it has been improved by Professor Forbes, and as made for him by Zeiss, of Jena, it has been converted into an instrument of precision. Double-reflecting prisms are substituted for the mirrors, the angle of reflection thus being made constant regardless of the exact position of the prism. The telescope is replaced by a binocular, and the measurements are made by a micrometer screw moving a wire in the focal plane of the binocular. There are two wires in the two tubes of the binocular, and by moving one of the wires until the two are seen as one while the object is also seen distinctly, the distance can be read within a limit of 2 per cent. of the truth.

Professor Forbes gives some interesting details of the construction of his instrument, which is shortly to be tried in South Africa, and if it meets with approval in the difficult conditions existing there it will be welcomed in military, naval, and exploring circles everywhere.

The Spontaneous Combustion of Coal.

In an interesting letter delivered at the Royal Service Institution, and published in the *Colliery Guardian,* Commander W. J. Caborne presented the latest views upon the subject of the spontaneous combustion of coal on board ships and the importance of the subject is such that some abstracts from the paper and the discussion upon it will be found useful. It is most desirable that proper precautions be taken to prevent the occurrence of spontaneous combustion, but such precautions can only be intelligently taken when the cause of the combustion is known.

Coal naturally absorbs oxygen from the air, and undergoes a process of slow combustion. As the process goes on heat is developed, and the temperature of the coal tends to rise. The activity with which oxygen is absorbed increases as the temperature rises. It appears, therefore, that the conditions necessary for the spontaneous heating of coal are a sufficient supply of oxygen, prevention of the escape of the heat generated. These two conditions are more or less incompatible. Whether the coal heats or not depends on whether the heat can or cannot escape as fast as it is generated. Since heat passes away more rapidly (other things being equal) the hotter the coal, while the supply of air for promoting combustion is conditioned by other circumstances, it often happens that the temperature of a heap of coal will rise to a certain point which it will not pass. If a heap of coal is prevented from coming in contact with the air no action will occur, and no heat will be developed. On the other hand, if the air supply be so free as to carry away the heat generated at a sufficient rate again no heating will take place. In order that spontaneous combustion may occur the supply of air must be nicely regulated. The kind of ventilation which used formerly to be employed with coal cargoes often supplied just the air necessary for spontaneous heating. At low temperatures the absorption of oxygen by coal is a comparatively slow process, and at a given temperature the rate of absorption depends on the ratio of the surface of the coal to its volume. Thus, other things being equal, the smaller the coal the more rapidly it will absorb oxygen. On the other hand, the coal cannot absorb oxygen unless the oxygen is there to be absorbed, and when the coal is in very fine dust the rate at which the air can penetrate the heap is only small. It therefore appears that when the coal is in large pieces it will only absorb oxygen slowly, because of the comparatively restricted area of surface which it exposes, while if the coal is in very fine powder the air will not be able to penetrate the mass with sufficient freedom. There is a general impression that coal is more likely to take fire spontaneously when moist than when dry, but the investigations of the New South Wales Commission, made in 1896, appear to show that moisture has no effect in promoting spontaneous combustion. A far more important point is the initial temperature of the coal, and its protection from the hot surfaces of the engine and boiler rooms. The rate of absorption of oxygen increases so greatly with a rise of temperature that the moderate warming of coal by a steam pipe or boiler may enormously shorten the time necessary for spontaneous combustion to set it, or may render it possible in cases where it could otherwise not occur.

The size of a heap of coal also has an important influence on the liability to spontaneous combustion. The experiments of Mr. Fayol showed that under certain circumstances a coal never took fire by exposure to the air when the heaps were less than 2 metres high, no matter what the lateral dimensions of the heap might be. The general theory of the spontaneous combustion of coal may then be thus stated:

Coal always absorbs oxygen from the air, and always generates heat in consequence of the combination of the oxygen with the carbonaceous contents of the coal. The rise of temperature, however, which accompanies this process is dependent on the rate at which oxygen is absorbed on the one hand and on the rate at which heat escapes on the other. Both of these factors may be greatly influenced by comparatively trifling variations in the conditions. The size of the coal, the distribution of coal dust, the initial temperature of the coal, the temperature of the enclosure in which the coal is placed, the size of the heap of coal—all have an effect on the temperature attained. To anyone approaching the subject for the first time the great puzzle is to understand why some cargoes fire and why others escape—all being under conditions which are identical. After a study of the phenomena, however, it easily appears that there must necessarily be a kind of critical temperature. If the coal succeeds in reaching this then its thermal equilibrium becomes unstable and the temperature rises indefinitely. A very slight difference in the conditions will determine whether this critical temperature, which itself depends on special circumstances, is attained or not. The puzzle above referred to is therefore solved by the remark that when some cargoes fire and others do not the conditions are not the same in reality, though, roughly speaking, they may appear to be so. The apparently erratic behaviour of coal cargoes is therefore just what would be expected, having in view the fact that very slight variations in the circumstances may make all the difference in determining whether the critical temperature will be passed or not.

The precautions to be taken for the prevention of spontaneous combustion, then, are these three: to avoid piling the coal too deep; to avoid shipping the coal at all hot, or in contact with hot surfaces; and to avoid ventilation, or the free introduction of air.

The use of sulphur dioxide, generated by burning sulphur in air, delivered to the bunkers by a blower, is advocated as a means for extinguishing fires in coal bunkers, and it is believed to be superior to either carbonic-acid gas or to nitrogen.

The Nature of Explosions.

Although explosives have been used for hundreds of years in the form of gunpowder, and for more than half a century in the form of the so-called "high explosives," the theory of their action is not even yet fully understood. A recent lecture by Professor Dixon, of Owens College, Manchester, upon the nature of explosives, published in the *Colliery Guardian,* gives the latest theories upon the subject, and contains much interesting matter.

The earliest, and for a long time the only explosive, gunpowder, consists of two combustible substances, sulphur and charcoal, mixed with a third substance, saltpetre, which supplies the oxygen, permitting very rapid combustion without the presence of air. In such a mixture the particles lie side by side, and the oxygen is supplied to the combustible particles from without. Since 1832, however, explosives of other kinds have been made, explosives in which the oxygen is enclosed in the structure of the body with which it is burned. This more intimate relation between the combustible and the supply of oxygen, greatly increases the rapidity of the combustion, with corresponding increase of the explosive effect.

Although gases are not directly used as explosives, it is by the action of gases that explosive effects are produced, and it is by the study of gases that our knowledge of explosives has mainly been obtained. Priestley, soon after the discovery of oxygen, experimented with mixtures of oxygen and hydrogen, and exploded them, forming water. It was in 1832 that the study of high explosives began, and in 1845 Schönbein produced gun-cotton, although it was not until 1865 that Abel showed that it could be rendered stable and reliable. Nitro-glycerine, discovered by Sobrero, in 1846, was introduced as an explosive by Nobel in 1863, and in 1866 he hit upon the idea of absorbing it in infusorial earth, producing dynamite, which was nothing but a solid solution of nitro-glycerine, and being solid could more readily be carried about. By dissolving gun-cotton in nitroglycerine the explosive action is modified, being made less sudden, and therefore more available for use in ordnance. From modifications of this mixture is derived the smokeless ordnance explosive, cordite.

Leaving the subject of explosives themselves Professor Dixon proceeded to discuss the nature of the explosion itself. The investigations of Bunsen, many years ago, led to his statements of the velocity of propagation of explosions in gases, namely that the propagation in oxygen and hydrogen was about 36 to 40 yards a second, and the propagation was slower in a denser medium. The later work of Berthelot and of Le Chatelier, however, has caused the figures of Bunsen to be greatly modified. According to their experiments an explosion in a mixture of hydrogen and oxygen travelled at an increased rate from the point of inflammation until in a very short time the rate became constant. Berthelot calls this rapid explosion the "explosion wave." The rate of explosion is a physical constant for each explosive mixture. It is independent of the diameter of the tube, and only slightly affected by the pressure on the gases. Professor Dixon's own experiments confirm and extend those of Berthelot. The rate of explosion is equal to the mean rate of movement of the burning gases at the temperature of the explosion, calculated according to the "molecular theory." Le Chatelier had shown that the flame began by travelling slowly at a uniform rate, that it then commenced to oscillate violently, and, finally, either the explosion wave was set up or the flame died down. There are thus three *régimes* of explosions—first, the uniform and slow combustion; second, the vibratory period; and third, the explosion wave. Mixtures of coal gas with air and firedamp with air show phenomena of the first and second kind. Ignited at the open end of the tube these mixtures burn at a uniform rate for a certain distance, and then the flame begins to vibrate. The vibrations acquire greater or less velocity according to the nature of the mixture and the conditions of the experiment, but the third *régime* of uniform maximum velocity is not set up. In narrow tubes the explosion soon dies out. The phenomena studied by Le Chatelier have been observed in a large scale in explosions in coalmines. It had been noticed that little damage was caused at the source of the explosion, and at a distance varying from 50 to 80 yards from the origin of the flame, while beyond that distance falls of roof, broken tubs, and blown-out stoppings testified to the violence exerted by the explosion. Great as the destruction is which an explosion of firedamp and air causes in a mine, it is fortunate that these mixtures do not detonate. The physical nature of detonation has thus been explained by experiments on gases, but other problems still remain. The mode in which chemical atoms unite, the dissociation of compounds, the variations in specific heat, are all subjects of extreme interest on which we may hope for more light from a study of explosions. It appears that M. Berthelot by an entirely different series of experiments has come to the same conclusion that Professor Dixon had previously come to—namely that gases explode with very great rapidity when the flame is allowed to run down a long tube or gallery. M. Berthelot, however, should have the credit of being first to publish his results, and he showed that the explosion rate of hydrogen and oxygen, instead of being 40 yards a second, is more like 3,000 yards a second, and other gases such as firedamp, mixed with oxygen explode at the rate of between 1,000 and 2,000 yards per second, and that consequently not only the rate of explosion but the pressure between these explosions is enormously greater than those imagined by the older experimenters such as Bunsen.

REVIEW OF THE CONTINENTAL PRESS

Steam Turbine Tests.

Ever since the earliest introduction of steam as a source of motive power attempts have been made to devise a successful and economical rotary engine, but such attempts have failed until the recent introduction of the steam turbine. Even yet there are many who fail to see how it is possible for a wheel which is blown around by the force of a steam jet to equal in economy an engine made with a packed piston operating in a bored cylinder. Actual tests, however, are more convincing than pre-conceived ideas, and hence it is desirable that the results of reliable trials should be widely discussed.

An interesting series of such trials is described in a paper in *Zeitschrift des Vereines deutscher Ingenieure,* by Herr Schmidt, some abstracts from which are given.

The cause of the trials was an altogether practical one, and hence the tests differ from those performed in an engineering laboratory. It was required to install new motive power in an old engine room, and the limitations of space made it desirable to use De Lavel steam turbines if a satisfactory performance could be obtained.

Since it is impossible to take diagrams from a steam turbine, there can be no indicated power, and the trials were based entirely upon the effective power, this being obtained from the current developed in the driven dynamos, or measured by a friction brake. The steam consumption was computed from the known discharging capacity of the nozzles, and also measured from the weight delivered to the condenser, the theoretical and experimental values agreeing within 1/10 of 1 per cent. The turbines, two in number, were of 100 h. p. each, the steam pressure 172 pounds per square inch, and the steam saturated. The boilers were fitted with a Hering superheater, but owing to losses in the piping and steam drum, the temperature of the steam at the throttle was only that due to the pressure.

Without going into the details of the trials, the steam consumption, for a run of 4½ hours, was 8.16 kilogrammes per effective horse power, or almost exactly 18 pounds. This included the steam required to drive the condenser pump, which is properly chargeable to the main engines; but deducting the steam required for the pump, the consumption for the main engines was 7.69 kilogrammes (16.92 pounds) per horse power. These results, to be comparable with those of cylinder engines, should be corrected by an amount representing the mechanical efficiency of the reciprocating engine, this varying with the type of engine, but ranging from 80 to 90 per cent. Making a deduction of 10 per cent. to reduce the above results to that of highly efficient steam engines it will be seen that the steam turbine is quite as efficient a machine as the reciprocating engine of the same power.

It has been pointed out that the steam turbine is especially well adapted for use with superheated steam, since there are no rubbing surfaces, no valves to keep tight, and no lubricants to become carbonized by the heat. In experiments made by Herr E. Lewicki at the Technical High School at Dresden, upon a non-condensing De Laval turbine of 30 horse power, the consumption by using steam superheated 336 degrees C., was 11.5 kilogrammes per h. p. hour, while with saturated steam it was 17.7 kilogrammes, an economy of 30 per cent. The higher temperature of discharge of the exhaust steam makes it desirable to employ it for heating the feed water.

An interesting feature of these tests at Dresden, is the observed fact that the resistance of the empty turbine is less in superheated steam than in air or in saturated steam. By driving the turbine by an electric motor it appeared that the resistance of the wheel was 1.3 h. p. less in saturated steam than in air, and with a superheating of 300 degrees C. this resistance was further diminished between 2 and 3 h. p. Further researches in this direction re in progress.

Herr Lewicki develops formulas for the steam consumption of steam for turbines of the De Laval type, based upon the steam pressure, the cross section of the nozzles and the specific volume of the steam, the constants being varied for saturated and superheated steam.

The steam turbine appears to be destined to improvement along the lines indicated by Herr Lewicki, namely, by an increase in mechanical efficiency, by the use of highly superheated steam, and by the use of the heat remaining in the exhaust in a regenerator.

Radiant Energy.

We have noticed in these columns already (July, 1901) the remarkable discoveries of Becquerel, the Curies, and Debierne, in the field of radio-activity of certain metals, especially uranium, polonium, and most of all the new metal radium, and now we note further interesting phenomena in papers presented by the same investigators before the French Academy, and published in *Comptes Rendus.*

The emission of rays of energy has been observed in but a limited number of elements thus far, but it has been found that a similar action may be induced in substances which of themselves are not active. Thus such inactive materials as copper, platinum, tin, glass, paper, etc., become radio-active when enclosed in a vessel together with a solid radiant salt of barium, and the same effect is found with solutions of salts of radium. This activity appears to be independent of the pressure or of the nature of the gas contained in the enclosed vessel. Some interesting phenomena may be thus produced. Thus there are certain substances which become phosphorescent when exposed to rays of light, and these substances also become luminous when placed within the range of activity of radio-active substances. Zinc sulphide, for example, is phosphorescent after exposure to the rays of bright light. If now two glass bulbs be connected by a double bent neck, and in one bulb there is placed a radio-active salt of barium containing a few milligrammes of radium, and a small quantity of zinc sulphide be placed in the other bulb, and the whole hermetically sealed, the zinc sulphide will become briliantly phosphorescent under the influence of the rays emitted by the radio-active materials in the first bulb, although these latter substances themselves emit no light. This luminosity is due to the activity communicated through the tube, and not by the direct rays emitted through the glass bulb. If a non-phosphorescent substance, such as copper, be placed in the second bulb, it will not become luminous, but it will instead emit rays which are, so to speak, induced by the action of the radiant substance in the first bulb.

A similar example of radio-inductivity is found with glass, the phosphorescent Thuringian glass becoming especially luminous. This induced activity appears to be depend essentially upon the free space existing between the two bodies. When the substances are placed very close together, say 1 millimetre distant, the radiant activity is weak, but when they are separated by about 3 centimetres, an active effect is produced.

The radio-activity, all other things being equal, appears to depend upon the quantity of radium introduced into the solution. For solutions containing the same proportion of radium the activity varies with the quantity of solution present, and in this respect it is not analogous to vapor tension.

These new developments in the domain of radiant energy may appear to belong, like those which preceded them, to the field of the physicist rather than of the engineer, but the laboratory physics of one decade becomes the applied engineering science of the next, and it is hard to draw any definite boundary line limiting the scope of either. Watt himself ascribed his practical development of the steam engine almost entirely to the lectures of Dr. Black upon the subject of latent heat, and the researches of Faraday and the theories of Maxwell form the basis of great manufacturing corporations to-day. When we admit that the apparently inexhaustible rays of energy from a chemical solution are capable of maintaining luminosity in an adjoining vessel for an indefinite period, we surely have a fact which is as probable to be of engineering value as the deflected floating needle of Oersted or the quivering frog leg on the laboratory table of Volta.

Sulphate of Lime in Feed Water.

We have already referred to the experiment of M. Boyer-Guillon upon the solubility of sulphate of lime in water at various temperatures, and their important bearing upon the question of the purification of boiler feed water. Now we have in the *Revue de Mécanique* a further paper by M. Boyer-Guillon detailing his experiments at length, and in view of the interest of the subject a brief reference is here made.

Sulphate of lime is well known to form a very hard and stubborn scale in steam boilers and its removal from feed water has always been desired. Carbonate of lime is readily precipitated by heat, being almost completely thrown down by heating the feed water to the boiling point so that with a large feed-water heater, with ample heating surface and space and time given for settlement, the carbonate may be removed by the temperature attainable with exhaust steam.

The temperature at which sulphate of lime is precipitated has been variously stated by different authors, the general idea being that about 300° F. (149° C.) corresponding to about 67 pounds pressure, absolute, all the sulphate of lime is precipitated.

The experiments of M. Boyer-Guillon, however, show that entire insolubility is not reached even at 200° C., and also that the time element enters into the question to an extent which should be taken into account in practice.

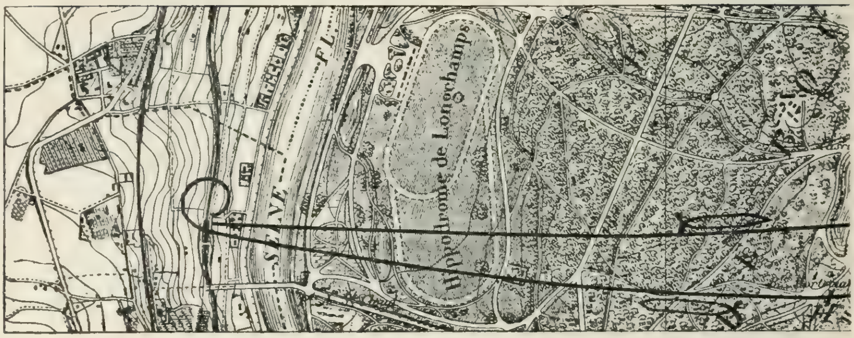
M. Boyer-Guillon approached the subject in a true scientific manner, by investigating, first the cause of the change in solubility of sulphate of lime by heat, and secondly the temperature or temperatures at which the action took place. A study of the chemistry of the subject showed that the sulphate originally exists in water in the hydrated form, containing two equivalents of water, and that by heat this is first converted into a hydrate containing half an equivalent of water, and finally appears in the anhydrous form.

Professor Van t' Hoff has stated that the first transformation occurs at 107° C., and this is sustained by the results of the present experiments, since the curve plotted from the results shows a sudden jog or change of direction at that temperature, and from that point the solubility diminishes more rapidly. The transformation into anhydride, however, appears to be more gradual, and does not reveal any critical temperature in the curve.

The apparatus used in the experiments is described and illustrated in full detail in the paper. The method consisted in preparing a standardized solution of sulphate of lime in distilled water, in heating it to a recorded and uniformly maintained temperature, and in filtering it at this temperature, the precipitate being subsequently weighed. The care which was given to all the details of the work certainly render these researches far superior in point of precision and accuracy to any which have heretofore been made. The precipitates were carefully anlaysed, the apparatus thoroughly calibrated, and the results may be accepted as reliable and trustworthy.

In general these results are stated as follows: The solubility of sulphate of lime in water increases from 0° to 34° C., at which point the maximum is reached. From thence it slowly diminishes until a temperature of 107° is reached, this being the point of transformation from a sulphate of 2HO to a sulphate of ½HO. The solubility then decreases more rapidly, although the rate is not uniformly maintained, until at 200° the solubility reaches 0.15 grammes per litre, or 0.015 per cent.

These valuable experiments should have an important bearing upon the design of apparatus for the purification of feed water for steam boilers. By far the greater portion of the scale in land boilers is formed from the deposit of suspended matter, mud, clay, etc., and from the precipitation of carbonate and sulphate of lime. The suspended matter may nearly all be removed by providing time and space for settlement, together with reasonable care for removal of the sediment from the purifier. The carbonate of lime may be precipitated by heating the water to the boiling point, which may be accomplished by the exhaust steam. The above researches show that practically all the sulphate of lime may be removed by heating to 200° C., corresponding to a pressure of about 250 pounds. This is not readily attained in an ordinary heater, but it is possible that in some form of special economiser the heat of the waste gases might be employed for this purpose, and practically pure water delivered to the boiler.



ROUTE OF M. SANTOS-DUMONT FROM ST. CLOUD

Dirigible Balloons.

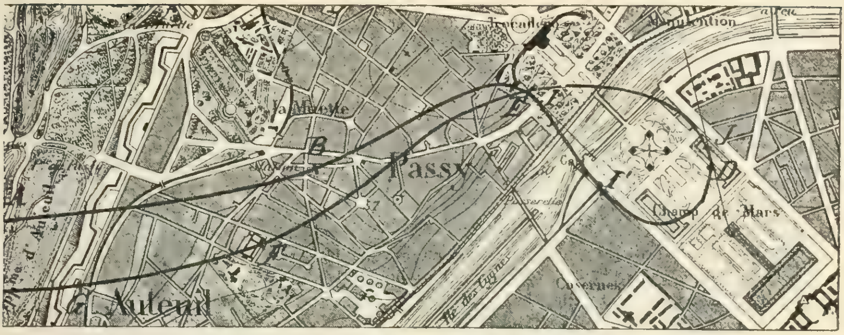
THE successful attempt of M. Santos-Dumont to win the Deutsch prize by making the trip from the Parc d'Aérostation at Saint-Cloud to the Eiffel Tower and return in 29 minutes, 30 seconds, has naturally attracted much attention to the subject of dirigible balloons and we find in recent issues of *Comptes Rendus,* various papers contributed to the French Academy upon the more scientific features of the subject.

It is naturally a matter of much importance to be able to plot upon a map the true path of a balloon, and M. Armengaud Jeune has developed a graphical method applicable to the problem. The path of a balloon is necessarily more or less waving, both in a horizontal and a vertical plane, but in every case a portion of a curved path may be replaced by the corresponding osculatory circle with a radius equal to the mean radius of curvature of the portion under consideration. Since the apparent velocity of the balloon is the resultant of its own velocity and that of the wind, it is necessary to determine these two elements within reasonble limits; or, if one element is given and the actual speed is observed, the other element may be computed. Now in certain portions of a complete trip such as that under consideration, the observed velocity is equal to the actual velocity, while at other portions the wind acts either to assist or to retard the velocity of the balloon. M. Armengaud shows how to construct diagrams based upon the theory of instantaneous centres of motion, as indicated above, so that the portion of the path in which the observed velocity of the balloon equals the real velocity may be detected. Assuming this velocity to be constant, the influence of the wind during the other portions of the trip may be computed, and by observing the times of the passage over known points, all the elements for the computation of the entire path are obtained.

M. Armengaud has plotted the path of the successful trial of M. Santos-Dumont of October 19, 1901, upon the military map of that portion of Paris included in the trial, and his diagram is reproduced herewith as an interesting record. The scale of the map is equal to 1:32,700. In his paper M. Armengaud gives the details of the observations for the data upon which the plan is based, the whole making a very interesting record of a memorable occasion.

The question of the determination of the actual velocity of the balloon is also discussed in a paper in the *Comptes Rendus,* by M. H. Deslandres, who gives equations for the determination, the velocity of the wind being noted. His results, which agree substantially with those of M. Armengaud, or about 8.5 metres per second, (a little more than three miles an hour) show a notable advance in speed over the results of the trials of Renard and Krebs in 1884, and of the brothers Renard in 1885, when the maximum speed attained was 6.5 metres.

Much of the progress exhibited in these recent experiments is due to the development of light and powerful motors. In 1885 the motor used weighed 50 kilogrammes per horse power developed, while at the present time the weight is but 5 kilogrammes, or for the same weight, ten times the power may be developed. Since the speed of the balloon is proportional to the cube root of the power, this should result in more than double the speed.



TO THE EIFFEL TOWER—PARIS, OCTOBER 19, 1901.

The two balloons of 1885 and 1901 had the same general form, the first having 55 square metres surface and being propelled by a motor of 9 horse power, while the second (Santos-Dumont No. 6.) had 28 square metres surface and a motor of 20 horse power. Assuming that the resistance of the air is proportional to the surface of the balloon and to the square of the velocity, it may be computed that the balloon of 1901 should have attained a velocity of 10.6 metres per second, instead of 8 to 8.5 metres. The principal cause of the discrepancy was the pitching of the balloon, which was especially marked in the second machine. The pitching, which interferes materially with the speed, has a variable amplitude, depending upon complex laws, and increasing with the speed. This is undoubtedly the principal obstacle against which dirigible balloons have to contend, since the speed should attain 13 metres per second in order to be able to contend with the wind eight times out of ten. There is therefore the difficult contention between two opposing problems in the design of a successful dirigible balloon, the attainment of a high speed and the securing of a high degree of stability when in motion. With these requirements must be included the need of a still lighter and more powerful motor, so that the problem of the construction of an entirely successful dirigible balloon must still be considered but partially solved.

We have reviewed elsewhere in this issue the experiments of Mr. Wilbur Wright along the same lines as those originated by the late Mr. Lilienthal, and it is not improbable that some of Mr. Wright's experiences may apply to the balloon of Santos-Dumont.

The Industrial Uses of Alcohol.

SEVERAL months ago, (November, 1901,) we noticed in these columns the paper of M. Lucien Perissé contributed to the transactions of the Société des Ingénieurs Civils de France upon the conditions existing for the economical use of methylated alcohol in internal motors. Since that time there has been held, in the court of the Grand Palais des Champs Elysées, in Paris, an exposition of apparatus and methods of utilising alcohol in the arts, and from papers by M. G. Coupan, and M. H. Guérin, in *Le Génie Civil* we abstract some of the prominent features of the exposition.

The necessity of providing some commercial outlet for the amount of alcohol produced in France will be understood when it is stated that the total production of alcohol in France for 1898 was 2,400,000 hectolitres (52,851,000 British gallons), and that this has been greatly exceeded with the remarkable production of wine during the past year, and with the production of alcohol from the waste products of the beet-sugar factories. It has been found impossible to export the excess product in competition with the production of other countries, and in consequence an outlet is sought by providing new applications, and it was to desseminate knowledge of these applications that the exposition was organized.

The exhibits were divided into three classes, the first consisting of stationary motors, portable engines, and carburetters; the second of automobiles and motors for navigation; while the third contained apparatus for heating and lighting.

For all industrial purposes the alcohol is *dénaturé*, or rendered unfit for drinking, by the addition of a certain portion of methylated spirit, while for use in motors it is also frequently carburetted with benzine or some other hydrocarbon, in order to enrich its calorific value.

Fifteen motors were exhibited, and these were tested in a very thorough manner, in order to determine the value of alcohol as a source of motive power. The tests were made at full load, half load and no load, both with ordinary methylated alcohol and with alcohol carburetted to 50 per cent. The power generated was absorbed by brake, and the fuel in each case was subjected to chemical analysis. The results of the tests are fully tabulated in the paper of M. Coupan, and the general figures only can be given here. The methylated alcohol itself shows in the Mahler bomb a calorific power of 5,900 calories per kilogramme. The alcohol carburetted with benzine or coal-tar naphtha has a calorific power 1.43 times that of the pure alcohol, so that the consumption of the carburetted alcohol may be reduced to its equivalent of pure alcohol by multiplying by 0.7.

The consumption per h. p. hour ranged from 0.630 kilogramme and over for the small motors or 2 h. p. and under; 0.500 kilogramme for the motors between 2 and 10 h. p.; and 0.382 kilogramme for the one motor of 16 h. p.

The automobiles were tested upon a track, and the tabulated data and results give the consumption per ton-kilometre, the average being 0.128 kilogramme of alcohol, carburetted 50 per cent., speeds as high as 48 kilometres per hour being attained.

Quite as interesting as the applications of alcohol for power are its uses in connection with lighting, and it is this portion of the exposition which is discussed by M. Guérin.

The feeble illuminating power of the alcohol flame renders it necessary to utilise the heating effect to raise another substance to incandescence, and in nearly all the lamps exhibited the arrangement was that of an alcohol flame to heat an incandescent mantle of the Welsbach type. Many of these lamps were of high power, using a forced blast and an intensified draught. By vaporising the alcohol under pressure, and mixing it with air, illuminations as high as 634 candles were obtained from a single burner, the general arrangement being similar to the well-known petroleum incandescent lamps of high power.

A number of such lamps are described in detail of M. Guerin, including the Denayrouze, Kornfeld, Washington, Delamotte and others. In some of these the ordinary methylated alcohol was used, and in others the carburetted fluid, as in the motors. The only data of consumption available for record is that of the Hantz lamp, which gave a light of 8 carcels for 7 hours with a consumption of 1 litre of alcohol, and a light of 13 carcels with the same consumption for 5 hours. This corresponds to a consumption of 13 to 14 grammes of alcohol per carcel-hour.

The heating appliances resembled very much those in general use in the United States for use with gas, and with these were several forms of burners and appliances for industrial purposes which should prove very useful.

The whole result of this exposition should be to give alcohol a fair trial in the broad fields of heating, lighting, and motive power on a commercial scale, and while it is not to be expected that it will become a fuel of general adoption, there is little doubt that it is only the question of price which shall limit the consumption of the surplus output in this manner. Legislation and the regulation of taxation will doubtless have much to do with the cost, and if it can be made certain that the product can be so permanently unfitted for drinking as to make fraud impossible, the question of taxation may possibly be eliminated, and the laws of supply and demand be permitted to regulate the price.

The Deformation of Wires.

The question of the resistance of materials is far from being as simple as it was formerly considered, and the attention of the engineer is being directed in many ways to apparent anomalies which should lead him to be very cautious in making assumptions which formerly would have been considered entirely legitimate.

An excellent example of this is found in the results of a study of the deformations of metallic wires under various stresses, made by M. E. Lenoble in the mechanical laboratory of the Faculty of Sciences of Lille, and presented by him in a paper before the Société Industrielle du Nord de la France. From a publication of his paper in a recent issue of *La Revue Technique* we make some abstracts, showing the general trend of his observations.

If we assume a wire suspended with a weight attached to the lower end and are provided with means for determining its variations in length for various changes in load we may make the following experiments. Starting with a load sufficiently great to stretch the wire taut, we may add a succession of supplementary weights, recording the changes in length of the wire, and then, by successively removing the weights we may return to the original loading. The wire will then have passed through what M. Lenoble terms a cyclic variation of load, or a double oscillation. Under these conditions the wire frequently fails to return to its original length, but instead is permanently deformed. If it is now subjected to a second cycle, there will follow a second permanent deformation, and this may be followed by a third, etc.

By plotting the curves corresponding to a series of such cycles, M. Lenoble shows that the ascending curve of any cycle lies at first below the previous descending curve, but subsequently crosses it in ascending to a higher value, this operation being repeated for each cycle until rupture occurs. If the loading and unloading be continued many times, keeping within the elastic limit, the paths traced by the elongations and contractions of the wire, which at first form loops, gradually coincide, thus forming what M. Lenoble terms a closed cycle.

The various cycles depend largely upon the state of the metal, a much greater number of oscillations being required for a soft or fully annealed wire than for one which is hard drawn. This fact led to the idea of using the method for the study of the effect of molecular disturbance upon the resistance of the material. Many series of tests and observations upon wires with loads far below those below the breaking strength, as well as with those near the point of rupture, the behaviour indicating very clearly the internal changes which must take place before yielding occurs.

Researches of this kind show the importance of investigating the behaviour of materials under the conditions which occur in actual service, and if we are to be assured of stability in structures and machines it is most desirable that the methods of testing be modified so as to reproduce in general at least the conditions of actual service. Metals are not carefully placed with the load acting in the precise geometrical axis, carefully applied up to the point of rupture without shock, as is frequently the case in high-class testing machines. On the contrary, materials are subjected to loads of varying magnitude at irregular intervals, often abruptly and with shock, and rarely in the axis of figure. While such conditions are supposed to be covered by the provision of a factor of safety, this is but a makeshift for more precise information, and any attempts to discover more accurately the real action of materials under working conditions, must be welcomed and encouraged.

The Conservation of Energy.

THE fundamental law of natural science —the law of the conservation of energy— is also the fundamental law of the science of engineering. It is with these words that Professor Kammerer opens a most interesting discussion of the law of the conservation of energy considered from the standpoint of the engineer, in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure.*

Thus the function of the engineer is to convert and distribute the forces of nature in such a manner as to free mankind from the burden of bodily labor, and place him at liberty for higher fields of culture. The most important work of the engineer lies in the conversion of the energy which the sun has accumulated in fuels as chemical energy and in water as hydraulic energy, into available mechanical energy through the medium of prime movers. This being accomplished, the further work of the engineer is to apply this mechanical energy to the tools and machinery of applied industry for the supplying of the material needs of mankind.

Viewed in this light it is seen that the true aim of the engineer should be to accomplish his results with the least expenditure of human labor and with the minimum loss both of materials and of mechanical energy. Of course the acceptance of the law of the conservation of energy precludes the idea that there can be such a thing as the loss of energy, and, from the standpoint of the engineer, energy can only be considered lost when it is misapplied, or deviated in direction from the line in which he is endeavoring to apply it. Useful energy, therefore, must be understood to mean simply that portion of the energy under consideration which has been successfully controlled and applied to the purpose in hand, as compared with that portion which has eluded capture and gone on its way unharnessed.

Some examples will render clear the manner in which an intelligent application of the law of the conservation of energy may conduce to the higher efficiency of a device, and an excellent instance is found in a hoisting plant, such as is used in mining. This is one of the simplest as well as one of the most important mechanical devices, and the history of its gradual improvement shows the advantage which the application of scientific principles may bring even to such a simple device as a windlass.

The earliest form of mine hoist consisted of a rope and bucket operated by a windlass, operated by animal or water power. The ore was filled into the bucket and hoisted to the surface by the energy applied to the windlass, and the empty bucket lowered again to the bottom. Here the useful energy was measured by the contents of the bucket and the velocity with which it was hoisted, while the energy from which no useful effect was obtained depended upon the weight of the empty bucket and that of the rope. Apart from the unused energy involved in the movement of the rope and the bucket, such a device is wasteful in other ways. Much time was lost in loading the bucket, and at the same time the slow speed of hoist possible with an unguided bucket in the shaft was far from economical. The entire time of descent of the empty bucket was also ineffective, so that the total efficiency of the device was unavoidedly low.

Consider now the manner in which improvements were introduced, and the extent to which they acted in accordance with the law of the conservation of energy.

By the introduction of a cage, controlled by guides, instead of a freely swinging bucket, the loading capacity may be materially increased, and greater rapidity of hoist allowed, but at the same time this introduces a greater proportion of dead load. The increased speed is a gain, but with it come increased resistances from friction and air resistance. The loss of time involved in the descent of the empty bucket or cage is next removed by the introduction of a second cage and double drum, one cage descending while the other in being hoisted, but with this gain comes additional dead weight. Thus we see a general increase in capacity, but also see it attained without material increase in efficiency. As an example of such a hoisting plant data are given from the salt mines at Heilbronn, where out of a total expenditure of 400 h. p., about 200 h. p. are effective, or an efficiency of 50 per cent. is attained. The shaft at Heilbronn is only 200 metres deep, but Professor Kammerer applies the same examination to the hoisting machinery of the Tamarack copper mine in Michigan, where, with a shaft 1,800 metres deep, but 1,600 h. p. are utilised out of 4,500 h. p.

The Tamarack machine is provided with conical winding drums, for the purpose of equalising the effect of the varying weight of rope, but Professor Kammerer points out that a better equalisation would be obtained by the use of suspended ropes or chains beneath the cages, and he constructs diagrams to show that with such equalisation the total energy required would be but 3,500 h. p., for a useful effect of 1,600 h. p.

It has been suggested that electric driving might be used for operating hoisting machinery, but there would be no advantage in so doing merely as a substitution for mechanical driving. If however, the machinery were so installed that the negative work of the descending cage and accompanying weights generated current for use in subsequent hoisting, a marked increase in total efficiency would necessarily result.

This is but a single example of the stages in which increasing efficiency in a machine may be traced to a gradually increasing conformity to the conditions imposed by the law of the conservation of energy. Many improvements are made, however, simply as the result of costly experience, slowly gained, when a thorough consideration of the physical laws involved would have led at once to high efficiencies.

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The Cost of Power.

NEXT to the cost of labor the cost of power probably enters into the total cost of manufacture to a greater extent than any other element. In some instances, indeed, such as the manufacture of calcium carbide, the power cost is the principal factor. With the rapid introduction of labor saving machinery the proportion which power bears to labor must be a continually increasing ratio, more and more of the actual work being performed by machinery, the human element being reduced to that of guiding and directing the power by which the work is effected.

It is not always easy to compute the exact cost of power, or to estimate the cost for any proposed undertaking, and hence the papers of Mr. C. D. Gray, in the *Journal of the Franklin Institute*, giving a systematic arrangement of data relating to the cost of power from various sources, and various localities should prove of much service.

Mr. Gray takes up successively animal power, wind power, water power, steam power, and gas power, gathering data from many sources, both as to cost of installation and cost of operation and maintenance, and follows these with some discussion of methods of power transmission and distribution.

Animal power is dismissed with brief comment, the data being mainly from old and well-known sources. Any attempt to determine the efficiency of human or animal power on a thermal basis is misleading, and indeed the latest researches indicate that the development of muscular energy is a result of direct conversion of the food into electrical energy, without the intermediate stage of manifestation as heat. The high cost of human energy limits its use to purposes in which the effort of the mind as well as that of the body is required, and for such other purposes as can best be accomplished by its use regardless of cost.

Wind power receives a passing mention, its irregular character outweighing its cheapness, except for certain purposes. In general the examples given show that for the small powers used the cost is about one-half that of steam power.

Leaving these comparatively unimportant prime movers, Mr. Gray proceeds to examine data concerning the two great sources of mechanical energy; water power, and steam power.

Since the cost of water power depends to a large degree upon the cost of installation of the plant, the character of hydraulic plants may be of two kinds, one in which a large quantity of water is available but having a small head; the other, in which a small amount of water is at hand, but with a large head. With the former the turbine class of water wheel is more generally used, with the latter the tangential or impulse wheel is usually employed. Good modern wheels of either style will give an average efficiency of 80 to 85 per cent when operated under the head for which they are designed.

The cost of plant varies with the character, ranging, in the tables given, between $24 and $120 per brake horse power. The average cost per horse power, not including dam, is $53.41, or with dam, $79.55. The actual cost of water power is given as $10.72 per horse-power year. At Niagara the selling price is $13 per h. p. year, and at Lawrence from $19 to $22, while the lowest price in Canada is $6.25. A fair average may be taken from $10 to $15.

The disadvanges of water power, apart from possible inconveniences of location, are the necessity for storage capacity for water, the difficulties connected with close speed regulation, and the probability, in any locality, of the gradual diminution of supply, owing to climatic changes.

The cost of attendance of water-power plants is less than that of steam, or other plants, and, on account of the absence of a fuel bill, the operating expense is very small; but, on the other hand, the first cost is large, and therefore the fixed charges are correspondingly greater than with other kinds of plants. The depreciation and repair bill is less than in the case of steam, an allowance of 4 per cent. usually being considered ample to cover these items, while the corresponding allowance for a steam or gas-engine plant is 10 to 15 per cent.

Coming now to steam power there are again various types of plants to be considered. While the steam engine may be considered to have nearly reached its limit of economy, there are some lines along which improvement may be expected. Thus the use of higher steam pressures, and the employment of superheated steam, are still to be further exploited, while the introduction of the steam turbine may develop possibilities for slightly increased economy. Taking existing pressures and engines, we have a large amount of data, which Mr. Gray has arranged and tabulated.

The average evaporation of modern steam boilers, from a list containing 37 water-tube, and 23 tubular boilers, is 10.86 pounds of water per pound of combustible. Taking the engine tests, they are grouped according to construction, and results given in pounds of steam required per horse power hour. Thus the average for simple automatic, non-condensing engines is 33.4 pounds per h. p. hour, while for simple Corliss non-condensing engines the steam consumption is 28.9 pounds. When engines of these types are operated condensing the consumption for the automatic engines is 22.2 pounds of steam, and for the Corliss engines, 20.2 pounds. The compound condensing Corliss engine, a type now generally adopted for power houses, gives, as an average of 57 tests, a steam consumption of 15.74 pounds per indicated horse power, while for triple expansion engines, the consumption is lowered to 13.3 pounds.

The cost of steam plant varies greatly with the locality, size, kind of machinery, etc. The average of 23 plants of various kinds ranges from $28 to $70, the average being $50, exclusive of cost of buildings. The operating cost is very variable, the factors including the kind and steadiness of load, the number of hours of service, the quality and cost of fuel, the efficiency of boilers and engines, and many others. The tabulated results range from 0.31 cents to 2.88 cents per horse power hour, the average being 0.95 cent, or very nearly one cent per horse power hour, of actual operation or from $30 to $70 per year according to the number of hours run.

The gas engine, originally supposed to be applicable for small powers only, is now pressing forward into the general field of prime movers. Engines of 100 horse power are not uncommon, and motors of 1000 horse power have been put into successful operation. The first and greatest advantage of the gas engine is its high thermal efficiency. With this comes the advantage of the possible use of inferior and low-priced fuel in gas producers. When it is practicable to use the waste gases from blast furnaces the fuel cost is that of a by-product, while natural gas is used to great advantage.

The calorific values of various gases are given by Mr. Gray, the tabulated values being grouped according to the method of generation, the averages of each table being given here. Thus natural gas averages 1,033 British thermal units per cubic foot, coal gas gives 706 B. T. U., water gas, when carburetted, 651 B. T. U., and when uncarburetted 319 B. T. U. Producer gas is much leaner, giving an average of but 143 B. T. U., while blast furnace gas yields only 102 B. T. U. per cubic foot. The quantity of gas used per horse power naturally varies with the value of the gas ranging from about 10 cubic feet per h. p. hour for natural gas to about 100 for the lean producer and blast furnace gases, but the relative cost of the gas must also be considered. Blast furnace gas is practically a waste product, while in a by-product recovery gas process, such as the Mond process, much of the cost of gas generation is saved.

In Mr. Gray's tables the cost of gas power ranges from about 1 cent per h. p. hour, using producer gas, to 3 cents per h. p. hour, using coal gas.

The cost of gas plants does not vary greatly from that of steam plants, the cost of producers or generators being about $11 per horse power, or about the same as that of steam boilers.

Taking the first cost of a gas engine plant as the same as that of a steam plant of the same capacity it will occupy less space, be much safer and require much less water. The producer requires less attention than the boiler, and the gas may be stored, thus avoiding difficulties of irregularity. Under such circumstances a horse-power hour may readily be produced from 1 pound of coal or its equivalent, so that when the cost of fuel is given, the cost of power may be determined.

Mr. Gray has certainly done good work in collecting and arranging the mass of data to which we have been able to refer but briefly, and his work will doubtless form the basis for many future computations.

Progress in Aeronautics.

THE somewhat showy performances of the exploiters of dirigible balloons have rather cast into the shade the less pretentious efforts of those who have been working with aeroplanes, but still there are many who believe that the problem of aerial navigation will ultimately be solved by a machine without a gas bag.

The experiments of Lilienthal, interrupted by his untimely death, have not been forgotten, and in an interesting paper, presented by Mr. Wilbur Wright before the Western Society of Engineers, and published in the *Journal* of the Society, we have an account of a continuance of those experiments, extending them to a much larger scale.

Mr. Wright divides the difficulties which obstruct the pathway to success in flying machine construction into three general classes: Those which relate to the construction of the sustaining wings; those which relate to the generation and application of the power required to drive the machine through the air; and those relating to the balancing and steering of the machine after it is actually in flight. The first two of these are to a certain extent solved but the third has not been fully appreciated nor its importance understood.

Lilienthal seems to have been the first man who really comprehended that balancing was the first, instead of the last of the great problems in connection with human flight. Leaving the question of motive power out of consideration, he devoted himself to a study of gliding flight, by using aeroplanes, launched from a suitable eminence. His success is attested by more than two thousand successful trips, and he lost his life only by a breakage of his machine.

Taking up the work where Lilienthal left off, Mr. Wright and his brother have constructed a larger gliding machine than has been attempted by any one, and with a boldness fully equal to that of their unfortunate predecessor they have succeeded in gliding for distances of nearly 400 feet, having the apparatus during that time in excellent control.

The principal differences between the machine of Wright and that of Lilienthal are in the methods of guiding and balancing. The method of control of Lilienthal, which consisted in shifting the body to cause the centre of gravity to coincide with the centre of pressure, did not seem sufficiently quick or effective, so a system was contrived consisting of two large surfaces on the double-deck plan, similar to that of Mr. Octave Chanute, and a smaller surface placed a short distance in front of the main surfaces in such a position that the action of the wind upon it would counterbalance the effect of the travel of the centre pressure on the main surfaces. Thus changes in the direction and velocity of the wind have little disturbing effect, and the operator is required to attend only to the steering of the machine, which is effected by curving the forward surface up or down. The lateral equilibrium, and the steering to the right or left is attained by a peculiar torsion of the main surfaces, which is equivalent to presenting one end of the wings at a greater angle than the other. The operator, instead of maintaining an upright position, lies horizontally, this offering less resistance to the wind.

The first machine constructed on these principles had 165 square feet of area, but experiments with it, while indicating that the work was on the right track, Lilienthal's tables of areas and supporting angles were found to be incorrect, and the lift was less than was needed, and after further experiments a second machine was built with an area of 308 square feet.

After some practice, especially in the modification of the curves of the aeroplanes this larger machine was got to work most satisfactorily, as photographs showing gliding flight prove.

Although such experiments serve to give information concerning only the third of the three obstacles to be overcome in successful flight, the balancing and guiding, yet this is in itself no mean achievement. The construction of a much larger machine, and its equipment with a light and powerful motor, so as to avoid the necessity of limiting flights to down-hill gliding, aided by the wind, and to permit predetermined progress and direction, may now be far more intelligently undertaken, and with such a combination a veritable flying machine would be produced, one differing as much from a dirigible balloon as an ocean liner from a Chinese junk.

Progress is evidently being made on all sides in the development of the essentials of mechanical flight, and not the least progress which has been made is the overcoming of popular prejudice against experimental work in this line. Not so very many years ago any engineer of reputation who ventured to countenance the construction of a flying machine would have found that reputation gone. To-day he meets with intelligent co-operation and encouragement, a fact which in itself shows the advance not only in the work of the engineer, but in the intelligence of the public.

The Pollution of Streams by Manufactories.

Among the various causes of the pollution of water supply that due to the discharge of manufacturing wastes into streams is an extensive and increasing one. For this reason the paper of Mr. H. W. Clark, chemist to the Massachusetts State Board of Health, in a recent issue of the *Journal of the New England Water Works Association* is both opportune and valuable.

Although the subject has received attention at various times, it is only within the past few years that it has been given systematic study and investigation, the disposal of domestic sewage having occupied the attention of most communities. Since 1895, however, a succession of practical investigations have been carried on by the Massachusetts board and much valuable practical information obtained. Many of the small streams of Massachusetts are at places, or along their entire course, foully polluted by waste liquors from various manufacturing plants. Some of the large rivers, such as the Merrimac, moreover, are receiving immense quantities of manufactural wastes, together with domestic sewage, and their waters are prevented only by reason of their volume from becoming as foul in appearance and character as the waters in some of the smaller streams. All this has been a natural consequence of the growth of manufacturing industries, but in the light of present knowledge, it is evident that there will arise a demand for such a cleaning up of rivers now polluted from factory wastes as can reasonably be required from the corporations responsible.

An examination of the subject shows that the principal manufactural pollutions are from woolen mills, paper mills, and tanneries. Other industries cause much pollution in places, but they are not so widespread.

Mr. Clark examines in detail the nature of the wastes of these three principal kinds. The wastes from woolen mills are principally those caused by the scouring and rinsing of wool in preparation for its manufacture, together with the waste liquor, in some instances, from washing the cloth after manufacture. They form a serious pollution, both on account of the large amount of organic matter present, and because of the extreme difficulty with which this matter is decomposed or changed by bacterial action. Thus investigations show that one mill discharged about 67,000 gallons of liquor per day, carrying 12,000 pounds per day of solid matter. In a second mill, where the scouring was more concentrated, being carried on with a less volume of water, the solid matter discharged amounted to 7,500 pounds for each 12,000 gallons of wool liquor. Experience shows that such a liquor cannot be caused to nitrify when passing through intermittent sand filters unless a certain volume of domestic sewage is added to it, but that when the volume of domestic sewage is very large in comparison with the volume of waste liquor, nitrification will occur, and good results be obtained. As the result of a number of experiments it appears to be conclusively established that the filtration area seems to gather power to purify the mixed town sewage and woolen-mill waste more efficiently after it has been applied to it for some time; that is, the bacteria present seem to become, after a time, more and more equal to the task of breaking up even the stable organic matters in the wool liquor, and causing them to undergo bacterial oxidation.

Tannery wastes form a very strong offensive liquor, highly charged with decaying animal tissues, the bran that is added to cause fermentation to take place in certain tanks, and various chemicals used in preparing, tanning, and preserving the hides. It is also at times highly colored by the different dyes used in coloring the hides, and the spent tan liquor. In spite of this general mixture the wastes show good results on sand filters. Thus one sand filter, containing four feet in depth of sand, to which this tannery sewage was applied at rates of 30,000 to 120,000 gallons per acre daily, gave a fairly clear, almost odorless liquid without much color, and well nitrified.

When germicides, such as arsenic, have been applied to protect the hides in transit, or when sulphide of arsenic is used in removing the hair, the presence of the arsenic checks or destroys the organic growths. Experiment has shown, however, that although this sewage will not nitrify in filters if applied directly, yet if it is first passed through a coke-breeze strainer or over iron filings, the arsenic present will unite with the iron, and the resulting liquor be of such a character that it may easily be purified upon intermittent sand filters. Such a sewage, although often nearly sterile before the preliminary straining through coke or iron, shows abundant bacterial growth when it appears as an affluent from this strainer before passing to the sand filter.

The waste liquors from paper mills vary very much but generally contain a large amount of slowly decomposable organic matter, such as cellulose and a small amount of easily decomposable nitrogenous organic matter. The principal difficulty which they offer is their volume, and they are easily purified when mixed with fair volumes of domestic sewage. A simple method of treating such wastes in large quantity, however, is to pass them directly through a coke or cinder strainer, it being found that even at rates as great as one million gallons or more per acre daily, the resultant effluent is of fairly good quality, and the polluting matters in the liquors, being largely in suspension, are caught at the surface of the strainer and may be removed and burned.

Besides the examination of the three main kinds of factory wastes the Board has investigated a large number of discharges of other kinds, usually with favorable results, special treatment being required in special cases. The main point, however, appears to be clearly established, namely, that the purification of factory wastes may be successfully carried on in connection with that of domestic sewage, without imposing hardships upon the factory owners, and with great benefit to the communities through whose areas the polluted streams pass. Absolute purity may not be practically attainable, but an excellent degree of purity is entirely practicable, to the great advancement of the cleanliness of the streams, and the health of all concerned.

Resistances in Canal Navigation.

In the recent report to the Governor of the State of New York upon the subject of the barge canal, Mr. Elnathan Sweet made reference to the bearing of the experiments of Herr Haack in Germany upon the resistance to be overcome in the navigation of the proposed 1,000-ton barge canal. These results were so different from those generally understood to exist that they became the subject of some comment and discussion, and in consequence Mr. Sweet has contributed to the *Proceedings* of the American Society of Civil Engineer a paper discussing some important phases of canal navigation as illustrated by recent experiments in Germany. The experiments referred to are those of Herr Haack, which Mr. Sweet describes and discusses analytically. The well-known reputation of the distinguished German engineer lends especial value to the experiments, and the discussion by Mr. Sweet places them before the profession in English-speaking countries in a very acceptable form.

The experiments were made on the Dortmund-Ems canal, near Lingen, the canal at this point being of the usual trapezoidal section, with a mean area of 600 square feet, and a mean centre depth of about 8½ feet. They were made by towing steel barges by means of a steam tow-boat, and the object was not only the determination, by accurate measurements, of the actual resistance at varying velocities and ratios of prism to boat section, but also the determination, by accurate instrumental work, of the precise condition of the prism of water in a canal while a vessel was being forced through it; on the theory that the relative conditions of this prism of water at rest and while a boat was moving in it, should form a measure for determining the entire resistance of the boat navigating it.

The theory, advanced by Haack, is as follows: When a vessel moves in a canal, unlike a vessel moving in open water where the water moves freely from all directions to fill the void behind it, the water can only reach this void by moving back through the narrow spaces between the boat and the bottom and sides of the canal. Immediately in front of the wave made by the boat's prow the water is absolutely at rest, while behind the prow wave, the whole length of the boat, and for some distance behind it, the water sinks below its position before being disturbed, with a back flow seeking to restore the normal position behind the boat. The extent of this sinking of the water surface and of the velocity of this negative current depend on the rate of the boat's motion, its model, the friction of its immersed surface, the friction of the canal bed, and of the water particles on one another.

The experiments of Haack were made with the steam tow boat Goedhardt, 68 feet long, 16.4 feet beam, and 5 feet draught, together with the steel barges Emden and Dortmund, these being exactly alike of 215 feet length, 26.9 feet beam, and 6.6 feet draught, except that the Dortmund was supplied with a boiler and engine for self propulsion. There was a third barge, the Lloydkahn, 180 feet long, 26.3 feet beam, and 6.6 feet draught, these giving a sufficient variety of ratios of immersed section to canal cross section to provide data and results of much value.

The analytical examination of the conditions is given in full in Mr. Sweet's paper, and the conclusions only can be given here. Instead of tabulating the results, they are presented in the form of curves, and a few figures from the several curves will serve to show the influence which the ratio of barge section to canal section has upon the total resistance. Thus with the Goedhardt, under her own steam, with the ratio of boat section to canal section of 8.50, the mean negative velocity for a speed of four miles an hour, was 0.5 foot per second, while for the Lloydkahn, with a ratio of boat section to canal section of 4.30, the negative velocity for the same speed was 2 feet per second, and for the Emden, with a ratio of 4.15, the negative velocity was 2.6 feet per second.

As Mr. Sweet says, there is no phenomenon, incident to canal navigation, where considerable speed is desired, so important in determining the proper section of canal prism as this of the negative current induced by its operation, as such current cannot be permitted to acquire a velocity destructive to the integrity of the earthwork, and he calls attention to the fact that these experiments of Haack are the first and only contribution to our knowledge of the subject.

Especially is it important that there should be sufficient depth of water under the boat. It is well known that when a boat moves in shallow water, the proximity of the boat's bottom to the ground retards the speed, owing to the friction among the particles of water lying between the boat and the ground induced by the boat's surface carrying along the water adhering to it, while the friction of the ground retards the water adjacent to its surface, thus setting up motion and friction among the particles of water between these surfaces.

While these results are all most valuable, especially from the fact that they were obtained from full sized boats in a navigable canal, it should be possible to extend them greatly by experiments made in a marine testing tank, such as that in the Navy Yard at Washington. The cost of providing a number of models of varying midship section would be small, and the admirable recording mechanism connected with the towing apparatus would permit the determination of all the quantities with a high degree of precision.

Modern Practice in Rolling Rails.

The behaviour of steel in response to various kinds of treatment has been a subject of study for many years, but it is only recently that the results of such study have been put into practical application in actual manufacture. Formerly everything connected with the manufacture of steel was empirical and arbitrary, being based entirely upon the results of experience. This state of affairs was followed by the introduction of testing machinery, and the physical properties appeared in specifications and efforts were made to conform to them in manufacture. Later came the realization of the importance of a correct knowledge of the chemical composition of steel, as influencing its strength and general behaviour, and the chemical laboratory was added, to enable the results in the testing machine to be accounted for, and in some measure to enable certain desirable results to be reproduced commercially. Still it was realized that there were other conditions which affected the character of the product, and as the influence of heat treatment and the nature of the effects of the mechanical operations of manufacture were studied it was found most desirable that they should be known and controlled.

The comparatively new science of metallography, or the study of the molecular structure of the metal by the examination of polished and etched sections under the microscope, furnished the means for the intelligent introduction of improved methods of working. The result has been a decided modification in the practice of working steel, and the effect which such modification has had upon the rolling of rails during the past year is discussed in a paper by Mr. S. S. Martin, in a recent issue of the *Iron Age*.

The requirement of the railway engineer is for rails which will wear well, and it matters little to him if the chemical composition conforms to certain specifications, or the demands of certain tests have been complied with, if after all the rail wears badly. Now it has been known for a number of years that rails with a non-granular structure have the best wearing qualities. This non-granular structure, moreover, is found especially in light rails, and it is not uncommon to hear comparisons made of the better wearing qualities of rails used a number of years back, compared with the heavier modern rails.

In order to explain the effect of temperature upon rolling, Mr. Martin examines the behaviour of steel in cooling, and shows that there are certain points of retardation in cooling, of sometimes even of perceptible increase of temperature, these being the well-known points of recalescence. Soft steel has three such points, but rail steel of 0.50 per cent. carbon has but one, this lying about at 700°to 725° C. The structure of the rail depends for the size of its granules upon the rate of cooling to this critical point, and the higher the temperature above the critical point, the larger will be the grains, while below the critical point no change of structure takes place. The best structure will therefore be obtained by rolling the rail as nearly as possible at the critical temperature. If the piece of steel in rolling is delayed at any point before finishing it will help the structure directly in proportion to the amount of reduction in the remaining passes, because, while the bar is being held, the structure is crystallizing, and the higher the temperature the larger the granules to the critical point.

To obtain a non-granular structure throughout the rail must be reduced earlier in the rolling, and the bar or bloom should not be reheated, but should be rolled direct from the ingot. The amount of reduction greatly influences the granular structure, since a single pass is incapable of breaking up the granular structure for more than a certain depth.

It is here that the importance of the study of the microscopic structure of the metal is of importance. Professor Albert Sauveur has prepared a set of micro-photographs showing the appearance of steel forged at 650, 850, and 1,100 degrees C., the temperatures having been measured by use of the Le Chatelier pyrometer. These photographs form excellent standards for comparison with actual work, and a brief microscopic examination of a specimen of a rail enables it to be compared at once with the photographic standard, the result indicating very closely the actual temperature at which the rail was rolled. This gives a ready means of determining rolling temperatures, and admits of no dispute or question, besides possessing the great advantage of being applicable at any time after rolling.

We thus have another most important example of the application of laboratory science to the commercial side of engineering, and an illustration of the impossibility of predicting the limit to the uses of scientific research. The use of the microscope for the study of the structure of steel was at first looked upon as something of interest to the professor, but altogether too refined and delicate for use in connection with actual work. To-day it may determine the acceptance of tons of material and the payment of thousands of dollars, and more important yet, it may prevent the breaking of a rail and the wreck of a crowded express train.

The Sewerage of New Orleans.

The question of the drainage of the city of New Orleans has been under consideration for a long time, but apart from political questions the nature of the problem has made it a difficult one of solution. As a consequence there has been the spectacle of a city of nearly 300,000 inhabitants, situated in a hot and unhealthful climate, practically entirely devoid of any systematic provision for the removal of sewage.

In a paper by Mr. W. T. Crotts before the Louisiana Engineering Society, and published in the *Journal of the Association of Engineering Societies*, we now have a very complete account of the system of drainage planned for the city under the auspices of its own department of public works, after all attempts at a successful solution by private enterprise had failed. This system, while presenting no startling novelties, is a thoroughly sound treatment of a difficult problem according to well-known engineering methods, the magnitude of the work rightly being considered good reason for avoiding untried methods, however correct and adaptable in theory.

The natural difficulties are those due to the peculiar contour of the city, extending for a great distance parallel with the Mississippi river, and of comparatively shallow depth, together with the fact that the low-lying situation afforded a very bad soil and an entire absence of available natural grades. The entire system has had to be designed with artificial grades provided by depth of excavation in the bad soil, and arrangements made for the pumping of the sewage and its delivery into the river.

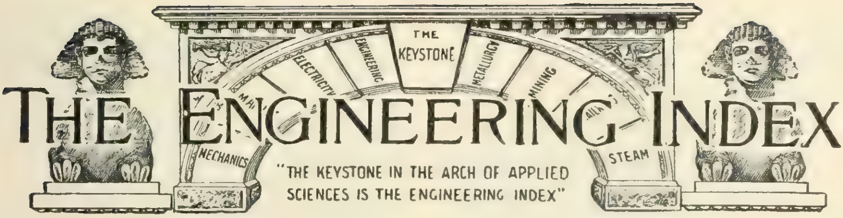
Before proceeding with the plans a careful investigation was made as to the distribution of population and the probable flow in cubic feet per second per acre, together with the probable direction and density of future growth in order to ascertain the future population for which sewerage facilities must be provided. With this was included an estimate for the ground water, an important element in this location, this alone forming 1,250,000 gallons per square mile in twenty-four hours. This quantity was estimated at one-third the annual rainfall, this estimate being checked by measurements made upon some of the old sewers.

The general system is naturally based on the topography of the city, and as the latter is situated on a bend in the river, with streets radiating from a hub situated far back, approximately at the centre of curvature of the bend of the river front, so the sewers are arranged to run back from the river front to a main collector situated about midway between the hub and the water front. The unit of the system is a pipe of 8 inches in diameter, and increasing in size as the flow increases the largest main finally attains a diameter of 6 feet for some distance before it reaches the pumping station. The larger sewers are of brick, resting on wooden foundations, while those below 24 inches are of vitrified pipe.

Naturally the greatest difficulty to be encountered is the soil. The grades must be obtained by underground slopes, while at the same time the work must be kept as near the surface as possible. The saturated and plastic character of the ground threatened damage to streets, curbs, and buildings wherever the deeper excavations became necessary, and yet a too shallow depth meant a too rapidly increasing number of dead ends and consequent first cost and annual expense of innumerable flush tanks. Taking all these points into consideration it was decided to adopt a minimum depth of 5 feet and a maximum depth of 9 feet for laterals, and 16 feet for sub-mains. These depths were not applied to the main sewers, for reasons of economy and efficiency.

Mr. Crott's paper contains very full details of the manner in which the whole of this difficult work has been planned out, and shows the completeness of a system the like of which can only be found, so far as local conditions are concerned, in the low-lying cities of Holland. The one redeeming feature in the situation is the presence of the Mississippi for a discharge of the pumped sewage. A series of careful experiments with floats showed the best point for discharge, where the current would carry the flow far away from the city, so that no trouble need ever arise from that cause.

THE ENGINEERING INDEX


THE KEYSTONE
ELECTRICITY
ENGINEERING
METALLURGY
MINING
MECHANICS
STEAM
"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCES IS THE ENGINEERING INDEX"

The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title, (2) The name of its author,
(3) A descriptive abstract, (4) Its length in words,
(5) When published, (6) Where published.
We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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BRIDGES.

Arches.

The Theory of Arches (Beitrag zur Theorie der Gewolbe). Th. Landsberg. A mathematical discussion of the determination of the line of pressure in masonry arches. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 14, 1901. No. 45163 D.

Bridge Testing.

Conférence sur l'Experimentation des Ponts (Report on the Testing of Bridges). M. Rabut. An important paper presented before the Engineering Congress at Paris, describing the construction and use if instruments for recording the deflection and vibrations of bridges in actual service. 10,000 w. Rev Gen des Chem de Fer—Nov., 1901. No. 45144 H.

Concrete Arch.

A Y-Shaped Concrete Arch Bridge at Zanesville, Ohio. Illustrated detailed description of a structure recently built to take the place of a wooden highway bridge, built to cross two streams which form a confluence in the midst of the city. 2000 w. Ry & Engng Rev—Dec. 21, 1901. No. 45007.

Fire and Load Test of a Concrete Arch. Charles L. Norton. An illustrated report of tests made with very satisfactory results. 2000 w. Ins. Engng—Dec., 1901. No. 44879 C.

Highway Bridge.

The Summer Street Bridge, Boston. Illustrated description of a 4-span highway bridge 100 ft. wide having heavy Pratt trusses and three steel piers of unusual construction. All special details are illustrated. 1500 w. Eng Rec—Dec. 21, 1901. No. 44998.

India.

Bridge Over the Indus River at Kotri, North-Western Railway. Illustration with brief description. 800 w. Ind & East Engr—Nov., 1901. No. 45035 B.

Monongahela.

Rankin Bridge for the Transit of Molten Iron. Illustrated description of a bridge across the Monongahela River for transporting molten metal to the Homestead Works. 500 w. Sci Am—Dec. 7, 1901. No. 44768.

New Mexico.

Rock Island Bridge Over the Canadian River in New Mexico. Illustrates and describes the erection of a bridge 769 ft. in length, spanning the river at a height of 135-ft., in which some unusual methods were employed. 1200. Ry Age—Dec. 6, 1901. No. 44825.

Ottawa.

Construction of the Substructure of the Royal Alexandra (Interprovincial) Bridge at Ottawa, Canada. Guy C. Dunn. An interesting description of this work with plates. 5000 w. Can Soc of Civ Engrs—Adv. Proof—Dec. 19, 1901. No. 45005 D.

The Interprovincial Bridge, Ottawa. Illustrated description of a cantilever structure 2,287 ft. long with a channel span of 555 ft., carrying a railway, two electric car tracks, two sidewalks, and two roadways. The first part describes the structural features. 4300 w. Eng Rec—Dec 7, 1901. Serial. 1st part. No. 44817.

Railway Bridge.

The South St. Paul Belt Railway Bridge. Illustrated description of a steel bridge and viaduct 1,632 ft. in total length, with one 442-ft. draw-span. A single-track railroad is carried on top and a highway floor is carried below it 2,700 ft. Eng Rec.—Nov. 30, 1901. No. 44662.

Rolling Lift.

A Scherzer Rolling Lift Bridge in Brooklyn. Illustrates and describes a bridge to be built on Vernon Ave. over Newtown Creek, which has novel features. 600 w. R R Gaz—Nov. 29, 1901. No. 44668.

CANALS, RIVERS AND HARBORS.

Dredges.

Dredging Machinery (Baggerwerktuigen). C. H. Holst. A review of modern dredging machinery, both bucket and suction; also barges and auxiliary machinery in dredging work. 4000 w. De Ingenieur—Nov. 30, 1901. No. 45207 D.

New Satre Dredges for Service on the Lower Seine. Illustrated description of seaworthy suction dredges built for the improvement of this river. 1100 w. Engng—Nov. 22, 1901. No. 44737 A.

Dry Dock.

New Dry Dock at Baltimore. An illustrated description. 2500 w. Marine Rev—Dec. 19, 1901. No. 45022.

Isthmian Canal.

International Aspects of the Isthmian Canal. Gen. Henry L. Abbott. A critical comparison between the Nicaragua and Panama routes, forming an impressive warning against the folly of accepting the former. 3500 w. Engineering Magazine—Jan., 1902. No. 45054 B.

Nicaragua or Panama. Philippe Bunau-Varilla. Address to the Chamber of Commerce of the City of New York, with editorial. A comparison based on reports of Commissions. 5500 w. Sci Am & Sci Am Sup—Dec. 21, 1901. Serial. 1st part. No. 44972 C.

The Report of the Isthmian Canal Commission. Editorial discussion of a few features of the report which are of special interest. 2000 w. Eng News—Dec. 26, 1901. No. 45057.

The Report of the Isthmian Canal Commission. Reviews the leading results of the investigation of this Commission, which has cost $1,000,000, and lasted several years. 1700 w. Eng Rec—Dec. 14, 1901. Serial. 1st part. No. 44934.

Mississippi.

The Lower Mississippi River: Physical Characteristics, Methods of Improvement, Character and Volume of Traffic. J. A. Ockerson. An illustrated descriptive article. 7500 w. Jour Assn of Engng Soc's—Nov., 1901. No. 45073 C.

Obstructions.

Obstructions in Navigable Channels. Discusses the question of bascule or vertically moving bridges as against the old-time center-pier obstructions in connection with the plans for bridges over the Potomac. 1200 w. Marine Rev—Dec. 12, 1901. No. 44895.

Savannah.

Savannah Harbor. A. S. Cooper. Describes the natural harbor and the improvements made. Ill. 3200 w. Wis Engr—Dec., 1901. No. 44996 C.

CONSTRUCTION.

Concrete.

Important Concrete Construction in Zero Weather. Describes the methods used in putting in heavy foundations for a grain elevator in Buffalo in mid-winter. 700 w. Eng Rec—Dec. 7, 1901. No. 44824.

Dams.

A Remarkable Core Wall for an Earth Dam. Describes the building of a concrete and puddle core wall to a depth of 105 ft. below the surface of the ground for a dam rising but 23 ft. above the surface. 1900 w. Eng Rec—Dec. 21, 1901. No. 44999.

Criticism of the Masonry Portion of the New Croton Dam. Letters from John D. Van Buren and Elnathan Sweet, with illustrations. 1800 w. Eng News—Dec. 26, 1901. No. 45058.

Report Recommending Changes in the New Croton Dam and Jerome Park Reservoir. Report submitted to the Croton Aqueduct Commissioners, with a statement relating to the matters covered by the report, signed by Mr. Sweet. Ill. 8800 w. Eng News—Nov. 28, 1901. No. 44659.

The Limiting Heights of Earth Dams. An editorial discussion on the effect of the percolation of water through dams. 1300 w. Eng Rec—Dec. 7, 1901. No. 44815.

Foundations.

A New System of Foundations (Nouveau Système de Fondations). A. Casse. Describing a method of sinking metallic caissons by the aid of water jets; especially adapted for wet and sandy ground. 2000 w. Mem Soc Ing Civ de France—Sept., 1901. No. 45119 G.

Notes on Foundations. Gerald E. Flanagan. Discusses the application of engineering principles to foundation construction. 1000 w. Am Mach—Nov. 28, 1901. No. 446[illegible]5.

Sinking Foundation Wells for the Koyakhai Bridge, Bengal-Nagpur Railway. Graves William Eves. Illustrated detailed description of methods used in difficult work in India. 2500 w. Eng News—Dec. 26, 1901. No. 45059.

Greenhouse.

The Largest Greenhouse in the World. Arthur C. Johnston. Illustrates and describes the construction of a greenhouse for rose culture at Edgely, Pa. 800 w. Eng News—Dec. 12, 1901. No. 44892.

Oiled Roads.

Oil for Clay Roads. Describes the treatment given a buck shot road near Clarkesdale, Miss. 1000 w. Eng Rec—Nov. 30, 1901. No. 44664.

Reinforced Concrete.

Concrete and Steel Prison Cell Construction, Boston Navy Yard. Illustrates and describes the cell construction in the prison at the Charlestown Navy Yard. 600 w. Eng News—Nov. 28, 1901. No. 44657.

Practical Applications of Reinforced Concrete. Jacques Boyer. A review of the principal systems, showing characteristic structures and methods of reinforcing concrete by imbedded metallic members. 4000 w. Engineering Magazine—Jan., 1902. No. 45047 B.

Reinforced Concrete Floors Constructed with Expanded Metal (Les Planchers in Béton Armé de Métal Déployé). With details of construction, strength, and cost, based upon work at the Elswick Works, Newcastle-on-Tyne. 1000 w. Revue Technique—Nov. 25, 1901. No. 45113 D.

The Applications of Reinforced Concrete (Des Applications du Ciment Arme). G. Liébeaux. Giving data concerning methods of construction and erection, with especial reference to works in and near Nantes, including the bridge over the Vienne at Châtellerault. 10,000 w. Rev Gen des Chem de Fer—Dec., 1901. No. 45145 H.

The Nassau County Steel-Concrete Court-House. Illustrated description of a 176 x 37-ft. building with 60 x 52 ft. extension, built with concrete-steel walls, columns, floors, roof, central dome, and ceilings. The details of design are explained and the method of construction briefly outlined. 2400 w. Eng Rec—Dec. 7, 1901. No. 44818.

See also Mechanical Engineering, Steam Engineering.

Steel Frame.

A Steel-Frame Church. Illustrated description of a 150 x 98-ft. stone and brick building with steel framework and roof. The vaulted ceiling of the nave rises 60-ft. above the floor, and there is a tower rising to a height of 125 ft. 1600 w. Eng Rec—Dec. 14, 1901. No. 44940.

Tunnels.

Simplon Tunnel (Simplon Tunnel). An abstract of the progress upon the Simplon tunnel works for the July-September quarter, 1901. 1800 w. Schweizerische Bauzeitung—Nov. 16, 1901. No. 45175 B.

The Flow of Water in the South Heading of the Simplon Tunnel (Wasserandrang auf der Südseite des Simplon-Tunnels). A detailed report of the sudden irruption of water into the Italian side of the Simplon tunnel works in September, 1901. 1000 w. Schweizerische Bauzeitung—Dec. 7, 1901. No. 45179 B.

The Flow of Water in the Simplon Tunnel (Irruption d'Eau dans le Tunnel du Simplon). An account of the sudden heavy discharge of water into the works of the Simplon tunnel in September, 1901. 800 w. Revue Technique—Nov. 10, 1901. No. 45112 D.

Tunneling.

The Pennsylvania Railroad Terminal in New York. Describes briefly the $60,000,000 plan for tunneling the North and East Rivers at New York and building a very large terminal station on Manhattan Island. 900 w. Eng Rec—Dec. 14, 1901. No. 44935.

Warehouse.

A Steel Warehouse for a Wholesale Grocery Company. Illustrated description of a 94 x 60-ft. steel-cage fireproof warehouse, 9 stories high, containing unusual features in the flooring and the arrangement of columns, made necessary by the nature of the business carried on. 1500 w. Eng Rec—Dec. 7, 1901. No. 44822.

The Design and Construction of the Modern Warehouse. Augustus N. Rantoul. Discusses the importance of the planning and of the economical and thorough construction if the property is to yield the best results. Ill. 2700 w. Br Build—Dec., 1901. No. 45067 D.

MATERIALS.

Cements.

Continental Opinion and Practice in Regard to Cement Testing. Resumè of the papers read at the recent Budapest meeting of the International Assn. for Testing Materials. 4200 w. Builder—Nov. 30, 1901. No. 44848 A.

The Inspection and Testing of Cements. Richard L. Humphrey. Reviews early tests made of this material, giving an illustrated account of the methods of testing developed; and discusses inspecting and sampling, chemical analysis, fineness, specific gravity, time of setting, etc. 6000 w. Jour Fr Inst—Dec., 1901. Serial. 1st part. No. 44844 D.

The Present State of Cement Testing in Germany. A report by Max Gary to the Budapest congress of the International Assn. for Testing Materials. Describes the standard Prussian tests and recommends alterations in the method of conducting them. 5400 w. Eng Rec—Dec. 14, 1901. Serial. 1st part. No. 44939.

Concrete.

Estimating the Cost of Concrete. Halbert Powers Gillette. Discusses the old theory and why it fails, and presents a new theory. 3500 w. Eng News—Dec. 5, 1901. No. 44795.

Fireproof Partitions.

Tests of Fireproof Partitions of the New York Building Department. A record of results obtained in a series of tests, with illustrations and editorial comment. The types tested were metal lath and plaster, terra cotta block, plaster composition block, and concrete block. 7700 w. Eng News—Dec. 26, 1901. No. 45055.

Resistance.

The Resistance of Materials (Von der Festigkeitslehre). A review of the development of the study of the strength of materials with especial reference to the theory of Mohr. 3000 w. Zeitschr Oesterr Ing u Arch Ver—Nov. 15, 1901. No. 45167 B.

Stone.

The Stone Industry in 1900. A review based on information given in a recently issued pamphlet of the U. S. Geol. Survey. 4800 w. Stone—Oct., 1901. No. 44809 C.

Variable Load.

A Diagram for Determining the Working Stress in Metals, with Variable Load. John H. Barr. Presents a graphical representation of the Johnson formula explaining its use and discussing the subject. 1700 w. Sib Jour of Engng—Dec., 1901. No. 44993 C.

Wood.

The Identification of Wood. Herbert Stone. An illustrated article outlining a plan for the identification and classification of timber. Discussion. 7700 w. Jour Soc of Arts—Dec. 6, 1901. No. 44909 A.

MEASUREMENT.

Metric System.

The Metric Convention and the International Bureau of Weights and Measures (La Convention du Métre et la Bureau Internationale des Poids et Mesures). C. E. Guillaume. M. Guillaume's second paper treats of the thermometric work, and also describes the various comparators used in the Bureau. 10000 w. Bull Soc d'Encour—Oct., 1901. No. 45129 G.

The Metric Convention and the International Bureau of Weights and Measures (La Convention du Métre et le Bureau Internationale des Poids et Mesures). C. E. Guillaume. M. Guillaume's third paper deals with the preparation and comparison of standards of length, also of the determination of the kilogramme. 12000 w. Bull Soc d'Encour—Nov., 1901. No. 45131 G.

Surveying.

The Closing of a Polygonal Survey by the Use of Modern Stadia Instruments (Festlegung eines Polygonalen Zuges bei Verwendung Neuer Instrumenten fur Optische Distanzmessung). E. Dolezal. A very full discussion and application of Prof. Schell's new tachymetric method. Three articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov, 22, Dec. 6, 13, 1901. No. 45168 each B.

MUNICIPAL.

Septic Tanks.

Drinking Water from Sewage. Describes a plant at Milton, Mass., showing how a septic tank converts household waste into a wholesome water supply. 2500 w. Dom Engng—Dec. 15, 1901. No. 45004 C.

The Antecedents of the Septic Tank. Discussion of paper by Leonard Metcalf. 5200 w. Pro Am Soc of Civ Engrs—Nov., 1901. No. 44686 E.

Sewage.

Sewage and Seaweed. Information concerning experiments made by Dr. E. A. Letts, of Belfast, showing that the occurrence of sea-lettuce in large quantities in any locality is associated with the pollution of the sea water by sewage. Also discusses schemes of sewage purification and means of mitigating the nuisance. 1200 w. Builder—Nov. 23, 1901. No. 44709 A.

Sewage Disposal.

Sewage Disposal at Wauwatosa, Wis. Illustrated description of septic tank and filtration works containing a new system of automatic control of the flow to the several filter beds. 1300 w. Eng Rec—Dec. 14, 1901. No. 44937.

The Continuous Filtration of Sewage. Editorial reviewing the continuous sewage filter of F. Wallis Stoddart. 1600 w. Engng—Dec. 13, 1901. No. 45042 A.

Sewers.

Estimation of the Cost of Sewer Construction. Emmett Steece. Read before the Am. Soc. of Munic. Imp. Gives an estimate of the cost of various kinds of work required in the construction, with diagrams. 2400 w. Munic Engng—Dec., 1901. No. 44758 C.

The Melbourne and Metropolitan Sewerage System. Illustrated description of the leading features of a separate system for an area of 200 sq. miles and an ultimate population of 1,000,000. The manholes, flushing apparatus, sewer construction, tunnelling and sewage disposal by irrigation are the principal subjects taken up. 3000 w. Eng Rec—Dec. 21, 1901. No. 44997.

The New Drainage and Sewerage System of New Orleans. Frederick Moore. An illustrated description of an installation presenting many difficult problems. 1300 w. Sci Am—Dec. 7, 1901. No. 44769.

The Sewerage of New Orleans. W. T. Crotts. Describes the conditions existing, the various schemes presented at different times, the final plan and its design. Ill. 5700 w. Jour Assn of Engng Soc's—Nov., 1901. No. 45075 C.

Street Lighting.

Prices of Electric Street Lighting in Massachusetts. Alton D. Adams. Considers the prices paid for the service of electric street lamps by all the important cities and towns of Massachusetts, with the object of determining whether variation exists, its extent, some of the modifying factors, and the exceptions. 3000 w. Munic Engng—Dec., 1901. No. 44757 C.

WATER SUPPLY.

Analysis.

The Bacteriological Analysis of Water and Its Interpretation. Charles Edward Amory Winslow. Explains quantitative analysis and the methods for the discovery of the typhoid bacillus, and the colon bacillus, and the value of these tests. General discussion follows. 11000 w. Jour N Eng Water Wks Assn—Dec., 1901. No. 44880 F.

Cleveland, Ohio.

The Cleveland Water Supply Tunnel. S. J. Pierce. Presents observations made and results shown during the construction of a tunnel under Lake Erie. Geological features. 1800 w. Am Geol—Dec., 1901. No. 44992 D.

Dams.

See Civil Engineering, Construction.

Detroit, Mich.

Recent Operating Experience in the Detroit Water Department. A statement from official reports of the cause of the very large draught on the Detroit waterworks, with the official suggestions for remedying it. 2100 w. Eng Rec—Dec. 21, 1900. No. 45000.

Distribution.

The Best Slope and Pipe Diameters for a Water Works Plant (Günstige Grabenneigung und Rohrweite bei Wasserkraft Anlagen). Dr. Ph. Forchheimer. A discussion of the effect of slope and cross section upon the efficiency of a water distribution system. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 15, 1901. No. 45166 B.

Filters.

The Efficiency of the East Providence Mechanical Filters. An explanation of the action of a half-million-gallon plant during a run of 20 months, the efficiency in removing color as well as bacteria being given. 600 w. Eng Rec—Dec. 7, 1901. No. 44819.

Ground Water.

The Movement of Waters in the Earth (Wasserbewegung durch Boden). Ph. Forchheimer. A comparison of the results of various experimenters with the observed facts in nature. Two articles. 10000 w. Zeitschr d Ver Deutscher Ing—Dec. 7, 14, 1901. No. 45160 each D.

Inspection.

The Work of Sanitary Inspection on the Metropolitan Water Works. William W. Locke. Calls attention to the dangers to health where surface water works are in operation, and suggests some of the agencies through which pollution may be prevented. Also discussion. 3500 w. Jour N Eng Water Wks Assn—Dec., 1901. No. 44881 F.

Pipe Specifications.

Standard Specifications for Cast-Iron Pipe. An explanation of the principles adopted by a committee of the New England Water-Works Assn. in preparing standards for cast-iron pipe and specials. 1300 w. Eng Rec—Dec. 7, 1901. No. 44816.

Pollution.

River Pollution. Abstracts of papers, with the discussions, as presented to the conference on water supplies and river pollution. 8500 w. Jour Gas Lgt—Nov. 26, 1901. No. 44813 A.

The Pollution of Streams by Manufactural Wastes, and Methods of Prevention. H. W. Clark. Reports investigations upon the purification, or utilization of the wastes from industrial works, especially considering the wastes from woolen mills, tanneries, paper mills and silk mills. 5100 w. Jour N Eng Water Wks Assn—Dec., 1901. No. 44883 F.

Pumping Machinery.

See Mechanical Engineering, Hydraulics.

Reservoirs.

Clearing and Enlarging the Spot Pond Storage Reservoir, Metropolitan Water Supply. Caleb Mills Saville. Illustrated description of work to bring this reservoir in Massachusetts up to modern sanitary requirements. 3000 w. Eng News—Dec. 12, 1901. No. 44890.

Cleaning the Distributing Reservoirs of the Water-Works of Burlington, Vt. F. H. Crandall. Describes the work that is carried out twice each year. 900 w. Eng News—Dec. 12, 1901. No. 44893.

Railroading in a Reservoir. Fred H. Colvin. Illustrates and describes interesting features in the construction of Boston's work in connection with its new water supply. 1000 w. Loc Engng—Dec., 1901. Serial. 1st part. No. 44693 C.

The Needless Changes in the Jerome Park Reservoir Construction. Alfred Craven. An illustrated discussion. 2200 w. Eng News—Dec. 19, 1901. No. 44983.

Vermont.

Water Supplies of Vermont. Charles P. Moat. A statement of the conditions and the supplies, discussing the kind and quality of water furnished. 2700 w. Jour N Eng Water Wks Assn—Dec., 1901. No. 44884 F.

Water Power Failure.

Fall of the Fairhaven Water Tower. R. C. P. Coggeshall. Illustrations with an account of the disaster. 700 w. Jour N Eng Water Wks Assn—Dec., 1901. No. 44885 F.

MISCELLANY.

Abattoir.

The New Abattoir at Düsseldorf (Les Nouveaux Abattoirs de Dusseldorf). Describing especially the sterilizing and refrigerating plant. 1500 w. 1 plate. Génie Civil—Nov. 30, 1901. No. 45103 D.

Sanitation.

The Sanitation of a Country House. Max Clarke. Read before the British Archt. Assn. Discusses the sanitary requirements of houses, the drainage, foundations, walls, roofs, plumbing, sewage disposal, etc., etc. 11800 w. Builder—Nov. 23, 1901. No. 44710 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Africa.

The Cape to Cairo Telegraph. An illustrated article giving information in regard to the construction of the line. 1400 w. Sci Am—Nov. 30, 1901. No. 44648.

Cable Jubilee.

The Jubilee of Submarine Telegraphy. Reviews the first public employment of submarine telegraphy which took place fifty years ago—on November 13, 1851. 1500 w. Engr, Lond—Nov. 22, 1901. No. 44745.

Cables.

High-Tension Cables. Oscar Schaefer. Describes experiments made at the works of the Kabelwerk Duisburg, Germany, in August, 1897, discussing results. 2800 w. Elect'n, Lond—Nov. 22, 1901. No. 44717 A.

The German-American Cable (Das Deutsch-Amerikanische Kabel). A description of the Emden-Fayal-New York cable, including the instruments and method of operation. 3000 w. Electrotech Zeitschr—Dec. 5, 1901. No. 45201 B.

The Manufacture of Deep Sea Cables in America. Discusses points relating to the ability of the American manufacturer to make such cable, and the protection that should be afforded the industry. 2500 w. Elec Wld & Engr—Dec. 21, 1901. No. 45010.

Insulation.

The Determination of the Insulation Resistance of Telegraph Cables (Ueber die Bestimmung des Isolationuiderstandes von Telegraph kabeln). K. Strecker. Deriving curves from which the resistance can be deduced from a limited number of observations. 2000 w. Elektrotech Zeitschr —Nov. 14, 1901. No. 45191 B.

Leakage.

The Influence of Leakage upon Telephone Lines on Pupin's System (Ueber den Einfluss der Albeitung auf Oberirdische Vernsprechleitungen nach Pupin's System). Dr. F. Breisig. A mathematical analysis, showing the increased effect of leakage, and the necessity for superior insulation. 2000 w. Elektrotech Zeitschr —Dec. 12, 1901. No. 45204 B.

Police Telephone.

Police Department System Pan-American Exposition. Illustrated description of the interesting police system employed for official use by the police and guard departments, employing a telephone with a signalling apparatus. 1600 w. Telephony —Nov., 1901. No. 44701.

Space Telegraphy.

Marconi Signals Across the Atlantic. An account of the recent experiments made in signalling between St. Johns, Newfoundland. and Cornwall, England. Ill. 3000 w. Elec Wld & Engr—Dec. 21, 1901. No. 45011.

The Armstrong-Orling System of Wireless Telegraphy. Drawings, with brief explanatory extract, and unfavorable comment. 1000 w. Elec Engr, Lond—Dec. 6, 1901. No. 44913 A.

Speed Conversion.

Cable Speed-Rate Conversion Tables. E. Raymond-Barker. Presents a table of multipliers by which statements of telegraphic speeds, whether in siphon recorder or in Morse codes, may be reduced from one mode of expression to another with due regard always to the varying space factor. 1500 w. Elec Rev, Lond—Nov. 22, 1901. No. 44727 A.

Telephone Exchange.

Recent Common Battery Telephone Exchange Work in New York City. Herbert Laws Webb. An illustrated description of the recent conversion of the Cortlandt street district to common battery working. 4500 w. Elec Wld & Engr—Dec. 7, 1901. No. 44868.

The Economic Design and Management of Telephone Exchanges. Arthur V. Abbott. Notes from the experience of the writer concerning the economic design and management. The present article considers the factors in the problem of design. 2300 w. Elec Wld & Engr—Dec. 7, 1901. Serial. 1st part. No. 44869.

The National Telephone Co.'s New Telephone Exchange at Kensington. An illustrated detailed description of an exchange in England, typical of the latest practice. 2900 w. Elect'n, Lond—Dec. 6, 1901. Serial. 1st part. No. 44910 A.

The Post Office Telephone Exchange for the City of London. Illustrated detailed description of the central exchange in Carter-lane. 4200 w. Elec Engr, Lond—Dec. 6, 1901. No. 44912 A.

The Telephone Exchange Systems of the Maryland Telephone and Telegraph Company. Kempster B. Miller. An illustrated description of the system installed and the work that has been accomplished by this company. 2800 w. Elec Wld & Engr—Dec. 7, 1901. No. 44867

DISTRIBUTION.

Alternating Current.

Alternating Current as a Factor in General Distribution for Light and Power. Charles F. Scott. Considers whether for general distribution for lighting and power service it is desirable to utilize the current as alternating current or to convert it into direct current. 2000 w. Trans Am Inst Elec Engrs—Nov., 1901. No. 44678 D.

Notes on the Alternating Current System of Distribution. W. S. Barstow. Discusses the field of the alternating-current system and the requirements to enable it to enter the compact direct-current field. 1600 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44679 D.

Buffalo System.

The Buffalo High-Tension Cable Distribution System. Harold W. Buck. Illustrated description of this system and the methods employed. 1500 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44677 D.

Cities.

Distribution of Electrical Energy in Large Cities. Louis A. Ferguson. Describes the system employed in Chicago, and refers to similar systems in Europe. Recommends direct current for the lighting and power in the business and residence districts, and alternating current for the less closely built and suburban districts. 4000 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44675 D.

Distribution of Electricity in Cities of Moderate Size. William Lispenard Robb. Favors the three-wire, 220 volt system of direct current, in view of existing conditions, and discusses means of securing cheap production. 1800 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44681 D.

Faults.

Locating the Faults in Underground Distribution Systems. Henry G. Stott. Shows that with the large cables used in cities the application of the loop method is impracticable, and discusses three other methods, favoring the compass method. Ill. 1300 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44676 D.

Rotary Converters.

Rotary Converters. A. S. M'Allister. Concerning the satisfactory and economical operation. 2500 w. Am Elect'n—Dec., 1901. No. 44784.

The Operation of the Rotary Converter. D. B. Rushmore. Mr. Rushmore's second paper treats of the practical experiences met in the operation of the rotary converter, including starting, hunting, inversion, compounding, and speed control. 3500 w. Engineering Magazine—Jan., 1902. No. 45049 B.

Specifications.

Standard Specifications for the Installation of High Pressure Electrical Systems (Verschriften für die Errichtungen von Elektrischen Starkstromanlagen). The full text of the specifications proposed by the German Electrotechnical Society. 9000 w. Electrotech Zeitschr—Nov. 21, 1901. No. 45194 B.

Switches.

Connecting and Disconnecting Switches (Les Conjoncteurs-Disjoncteurs). G. Fiévé. Describing special forms of switches used in connection with the charging of accumulators and with the operation of dynamos in parallel. 4500 w. Mem Soc Ing Civ de France—Oct., 1901. No. 45123 G.

Three-Phase.

The Distribution of the Three-Phase System and the Operation of Single-Phase Circuits by It. W. L. R. Emmet. Favors the use of three-phase machines in general for alternating-current generation in central stations, even when the distribution is single-phase. 2500 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44680 D.

Three-Wire.

250-500 Three-Wire Distribution for Lighting and Power. Phillippo Torchio. Advocates the use of the three-wire, 500-volt system, discussing its advantages, and means of overcoming difficulties. 2500 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44682 D.

Underground Cables.

Inadvisability of Placing High and Low Potential Wires Through the Same Conduits or Through the Same Manholes. William Brophy. Read before the International Assn, of Munic. Elect'ns. Briefly describes the two underground systems in use, and discusses plans and methods for placing all wires underground, recommending the system adopted by the Massachusetts legislature. 3400 w. Elec Rev, N. Y.—Nov. 30, 1901. No. 44673.

The Practicability of Placing High and Low-Potential Wires in Separate Ducts in a Combined Conduit System. Charles F. Hopewell. A reply to an article by William Brophy. Discusses methods of construction and operation, and what is a safe distance for the separation. 2500 w. Elec Rev, N. Y.—Dec. 21, 1901. No. 45014.

Wiring.

Interior Wiring. Describes methods and gives tables for computing. 2000 w. Am Elect'n—Dec., 1901. No. 44790.

ELECTRO-CHEMISTRY.

Chlorates.

The Electrolytic Production of Chlorates. John B. C. Kershaw. Describes the cell used by the National Electrolytic Co., of Niagara Falls. Ill. 1700 w. Elect'n, Lond—Dec. 13, 1901. No. 45027 A.

Edison Cell.

Theory of the Edison Nickel-Iron Cell. E. F. Roeber. Discusses the communication of Mr. Woolsey McA. Johnson, published in this magazine of Nov. 2, objecting to the conclusions. 2000 w. Elec Wld & Engr—Dec. 7, 1901. No. 44870.

Electro-Metallurgy.

Electrometallurgy in 1900 (L'Electrométallurgie en 1900). Paul Chalon. Reviewing especially the work of the electric furnace and its practical applications during 1900. 6000 w. 1 plate—Rev Univ des Mines—Nov., 1901. No. 45126 H.

Storage Batteries.

Storage Batteries on Electric Systems. Harold Seaman. Discusses the operation of the cells or units which make up the battery and its operation as a whole. 3500 w. Wis Engr—Dec., 1901. No. 44995 C.

ELECTRO-PHYSICS.

Accumulators.

The Losses of Energy in Accumulators. B. Hopkinson. A description of experiments made to ascertain definitely what the efficiency under different conditions might amount to. 2500 w. Elect'n, Lond—Nov. 29, 1901. Serial. 1st part. No. 44849 A.

Dielectrics.

Dielectric Constant of Paraffins. Will G. Hormell. Presents some experiments in which by means of a modified form of the Blondlot oscillator the dielectric constants of four commercially different paraffins were obtained for 40, 60, and 80 centimeter waves. Also other investigations of interest. Ill. 4000 w. Am Jour of Sci—Dec., 1901. No. 44674 D.

Induction.

Air-Gap Induction. F. W. Carter. A contribution to the subject of the distribution of magnetic flux over the surface of a tooth-cored armature, giving the solution of an ideal problem devised to resemble very nearly that of the magnetic flux between a smooth pole face and a toothed armature. Also editorial. 4200 w. Elec Wld & Engr—Nov. 30, 1901. No. 44695.

Radiography.

Studies Upon Radium (Etudes sur le Radium). M. Berthelot. With especial reference to the chemical properties of the new element radium. A paper before the French Academy. 1800 w. Comptes Rendus—Dec. 9, 1901. No. 45134 D.

The Radio-Activity Induced by the Salts of Radium (Sur la Radio-Activité Induite Provoqué par des Sels de Radium). P. Curie and A. Debierne. Describing the latest experiments showing the power of the salts of radium to induce fluorescence and phosphorescence. 1200 w. Comptes Rendus—Dec. 2, 1901. No. 45133 D.

The Radio-Activity of Uranium (Sur la Radioactivité de l'Uranium). A review of the observation which led to the discovery of the radio-active properties of uranium, with data as to the most recent experiments. 1500 w. Comptes Rendus —Dec. 9, 1901. No. 45135 D.

GENERATING STATIONS.

Alternators.

Alternators With Dampers. J. Fischer-Hinnen. Deals with the theory of copper loops linked with the field circuits of alternating current machines, on the basis of the theory of induction motors. Ill. 4400 w. Elec Wld & Engr—Dec. 28, 1901. No. 45066.

Artificial Loading of Alternating-Current Machinery. Rudolf Goldschmidt. Translated from the *Elektrotechnische Zeitschrift.* Discusses the heating of alternators, and methods of loading. Ill. 1800 w. Elec Engr, Lond—Dec. 13, 1901. No. 45029 A.

Experiments on Periodic Variations Occurring in the Exciting Current of an Inductor Alternator. W. Duddell and E. W. Marchant. A report of experimental investigations of the nature and magnitude of this induced alternating current in the field of an inductor alternator, in which the variation was known to be considerable. 1800 w. Elect'n, Lond—Nov. 29, 1901. Serial. 1st part. No. 44850 A.

Battery Connections.

The Proportions of Battery Connections (Dimensionirung von Zellenschalterleitungen). Discussing the most economical arrangement of accumulator cells and their connections, developing diagrams for practical use. 3000 w. Elektrotech Zeitschr—Dec. 5, 1901. No. 45200 B.

Central Station.

A Model Small Central Station. C. W. Obert. An illustrated description of the municipal lighting plant at Wappinger's Falls, N. Y. 1900 w. Am Elect'n—Dec., 1901. No. 44783.

Commutators.

The Commutation of Currents (Zur Theorie der Stromwendung). K. Pichelmayer. A brief mathematical examination of the conditions necessary to avoid sparking of commutators. 1000 w. Elektrotech Zeitschr—Nov. 21, 1901. No. 45193 B.

Compounding.

The Compounding of Alternators (Compoundirung von Wechselstromgeneratoren). A. Heyland. Discussing the arrangement of synchronous and non-synchronous generators, with diagrams showing the armature reactions. 3000 w. Elektrotech Zeitschr—Dec. 12, 1901. No. 45202 B.

Generating Sets.

Horizontal Engines and Dynamos of 3000 Horse Power (Horizontale Dampfdynamomaschinen vonje 3000 P. S.). Illustrated description of the Sulzer engines and A. E. G. dynamos in the Moabit station in Berlin. 2000 w. 1 plate. Schweizerische Bauzeitung—Dec. 7, 1901. No. 45178 B.

Standardization of Direct-Connected Engines and Dynamos. An illustrated report to the Am. Soc. of Mech. Engrs. 2000 w. Eng Rec—Dec. 7, 1901. No. 44821.

Hydro-Electric Plant.

Notes on Hydro-Electric Development Recently Completed Near Guadalajara, Mexico. M. A. Viele. Brief description. 700 w. Eng & Min Jour—Dec. 14, 1901. No. 44948.

The Electric Power Stations of the Fayet-Chamonix Railway (Les Usines Electriques du Chemin de Fer du Fayet à Chamonix). E. Javaux. Describing the two hydraulic stations near Chatelard in the French Alps (Haute Savoie). 2500 w. Mem Soc Ing Civ de France—Oct., 1901. No. 45122 G.

The Montgomery, Alabama, Water Power Plant. Illustrates and describes a plant for generating 5000 H. P. and transmitting it electrically, to be used for lighting and power purposes. 2000 w. Eng News—Dec. 5, 1901. No. 44793.

The Truckee River Electric Power Plant. Illustrated description of the hydraulic station at Floriston, Cal., where electricity is generated for use in the Comstock mines, 30 miles distant. 1500 w. Eng Rec—Dec. 14, 1901. No. 44936.

The Water Power Plant at Hannawa Falls, N. Y. From a paper by W. C. Johnson, read before the Am. Soc. of Mech. Engrs., with additional illustrations. Describes a plant for developing an 85-ft. fall on the Raquette River. 3200 w. Eng Rec—Dec. 7, 1901. No. 44820.

Isolated Plants.

The Economy of Isolated Electric Plants. Isaac D. Parsons. A Methodical study of the actual working costs of existing plants, showing the conditions under which isolated plants are advantageous. 4500 w. Engineering Magazine—Jan., 1902. No. 45046 B.

The Electric Plant at the Goldsmiths' Institute. Illustrates and describes an electric lighting plant which also provides current for educational and experimental purposes in the laboratory. 1000 w. Engr, Lond—Dec. 6, 1901. No. 44923 A.

Lighting Station.

The Bay Ridge Station of the Edison Electric Light Co. of Brooklyn. Illustrated description of the new installation of vertical engines. Calls attention to the rapid development in electric stations, as illustrated by the installation less than four years ago of 3000 h. p. double horizontal tandem compound direct-connected alternating current unit. 3000 w. Power—Dec., 1901. No. 44958.

Magnet Poles.

The Influence of Pole Arrangement Upon the Performance of Dynamos (Beurtheilung der Eigenschaften von Dynamomaschinen auf Grund der Nuthenanordung). Dr. M. Corsepins. A long analytical examination of the effects of pole arrangements with practical examples. Three articles, 10,000 w. Elektrotech Zeitschr—Nov. 18. Dec. 6, 12, 1901. No. 45197 each B.

Power House.

The Country Power Station at Crottorf, Saxony (Die Hochspannungs-Ueberland centrale. Crottorf i S.). Dr. Richard Apt. A description of an electric power station for the generation and distribution of power to country users. 3000 w. Elektrotech Zeitschr—Nov. 28, 1901. No. 45,-196 B.

Salford, Eng.

The Electricity Works of the Salford Corporation. Illustrated description of new works to furnish current for lighting and power. 3600 w. Engng—Dec. 13. 1901. Serial. 1st part. No. 45041 A.

Small Stations.

Stations for Electric Supply of Small Districts (Centraal stations voor Electrische Stroom levering in Klemere Gemeenten). C. D. Nagtglas Versteeg. Giving data of a number of moderate sized stations in Holland, and a description of the plant at Hilversum. 3000 w. De Ingenieur—Nov. 23, 1901. No. 45206 D.

Synchronism.

A New Synchronism Indicator for Alternators. Fred P. Woodbury. Illustrates and describes an instrument, invented by Paul M. Lincoln. 500 w. Sci Am—Dec. 7, 1901. No. 44767.

Tariffs.

Reform in the Charges of Electric Works (Vorschläge zur Tarifreform der Elektricitätswerke). K. Wilkens. Discussing rational formulas upon which proper charges for electrical energy supply may be based. 2000 w. Elektrotech Zeitschr—Dec. 5, 1901. No. 45199 B.

LIGHTING.

Arc Lights.

Changes in Arc Lighting. Alton D. Adams. A statistical review of arc-lighting in Massachusetts, showing the changes that have taken place. Also editorial. 3300 w. Elec Wld & Engr—Nov. 30, 1901. No. 44696.

Some Brush Arc-Light Dynamo Troubles and Their Remedies. F. B. O'Hanlon. Points from the experience of the writer. 1200 w. Am Elect'n—Dec., 1901. No. 44,-791.

Department Store.

Electricity in a Newark, N. J., Department Store. Illustrates and describes the arrangements for lighting which are said to be the best in the country. 2000 w. Elec Wld & Engr—Dec. 14, 1901. No. 44953.

Exposition.

Electricity at the Charleston Exposition. Charles T. Malcolmson. Describes the arrangements being made for power and lighting. Ill. 1400 w. Elec Wld & Engr—Dec. 14, 1901. No. 44952.

Lamps.

The Crawford-Voelker Incandescent Electric Lamp. F. Q. Maguire. Describes a new carbide of titanium lamp which it is said can be made with an efficiency of 2.3 watts per candle at 100 volts and for pressures up to 500 volts. Also extracts from report of tests. 2000 w. Elec Rev, Lond—Dec. 6, 1901. No. 44914 A.

Lighting Station.

See Electrical Engineering, Generating Stations.

Nernst Lamps.

Tests of Nernst Lamps. Translation of an article by Prof. W. Wedding, in a recent number of *Elektrotechnische Zeitschrift,* giving results of some experiments with Nernst lamps of different models, manufactured by the Allgemeine Electricitäts-Gesellschaft. 1200 w. Elec Engr, Lond—Nov. 22, 1901. Serial. 1st part. No. 44719 A.

Staten Island, N. Y.

Lighting and Railway Development on Staten Island. Max Lowenthal. Illustrated description of the New York & Staten Island Electric Company's system. History of the consolidation is given. 3000 w. Elec Wld & Engr—Dec. 28, 1901. No. 45065.

MEASUREMENT.

Permeameter.

A Direct-Reading Permeameter. Prof. F. G. Baily. Read before the British Assn. at Glasgow. Illustrates and describes the instrument and explains its use. 2000 w. Elect'n, Lond—Nov. 22, 1901. No. 44716 A.

A Permeameter for Testing the Magnetic Qualities of Materials in Bulk. Charles V. Drysdale. Read before the Inst. of Elec. Engrs., England. Illustrates and describes an apparatus for iron-testing, explaining methods and the principles involved. 4200 w. Elect'n, Lond—Dec. 6, 1901. No. 44911 A.

The Measurement of the Slip of Asynchronous Motors by the Stroboscopic Method (Messung der Schlüpfung Asynchroner Motoren nach der Stroboskopischen Methode). A. Schweitzer. Showing the manner in which Braun's tube may be used instead of the arc lamp, as described by Beniscke. 1000 w. Elektrotech Zeitschr—Nov. 14, 1901. No. 45190 B.

Slip Counter.

A Mechanical Slip Counter for Non-Synchronous Motors (Ein Mechanischer Schlüpfungszähler fur Asychronmotoren). E. Ziehl. A combination of a differential speed indicator and a small standard synchronous motor. 1800 w. Elektrotech Zeitschr—Dec. 12, 1901. No. 45203 B.

Testing.

The Stray Power Method of Testing Direct-Current Motors and Generators. William Lincoln Smith. Calls attention to the advantages of this method of testing the efficiency of direct-current machines. 1300 w. Elec Wld & Engr—Dec. 14, 1901. No. 44954.

Voltmeter.

A Simple Method of Calibrating a Voltmeter. J. Rowland Brown. An explanation of method, with diagram. 500 w. Am Elect'n—Dec., 1901. No. 44787.

POWER APPLICATIONS.

Berlin.

The Users of Electricity at Berlin. Reports the rapid development of electricity as applied to the various purposes of power and illumination, especially the phenomenal development of electrical tramways. 1000 w. U S Cons Repts, No. 1206—Dec. 5, 1901. No. 44748 D.

Cranes.

Notes on Crane Design. A. D. Williams. Discusses points in the design of electric cranes and their motors. 1300 w. Am Mach—Nov. 28, 1901. No. 44642.

125-Ton Four-Motor Overhead Electric Traveller. Sectional illustrations, with details embodying many new features and description. 1400 w. Engr, Lond—Nov. 29, 1901. No. 44862 A.

Electric Driving.

Electric Power in Carriage Works. Ernest D. Phillips. An illustrated description of the electric power plant recently installed in these reconstructed works at Saltley, near Birmingham, Eng. 4000 w. Engng—Dec. 13, 1901. No. 45039 A.

The Electrical Operation of Modern Machine Tools and Machines. Robert T. Lozier. Read before the N. Y. Elec. Soc. Shows what has been accomplished in overcoming the disadvantages of the entire belting system, and removing the objectionable features of the individual motor. Ill. 3000 w. Elec Rev, N. Y.—Dec. 21, 1901. No. 45013.

Elevator.

Self Contained Electric Elevator (Automobile Elektrische Aufzüge). A description of the Wüst system, in which the motor and winding mechanism is carried on the car. 1000 w. Glasers Annalen—Dec. 1, 1901. No. 45174 D.

Mine Power.

Electric Power in Mining (Elektricität im Grubenbetriebe). A general review of the advantages of electric driving in mining, with examples of successful practice. 1200 w. Glasers Annalen—Dec. 1, 1901. No. 45173 D.

German Electric Plants. Illustrates and describes an example of the slow-speed three-phase electric motor now extensively used for driving pumps in mines in Germany, and the accessory plant on the surface in connection with the system. 2500 w. Engr, Lond—Nov. 22, 1901. No. 44744 A.

Motor Diagrams.

The Numerical Computation of Three-phase Motor Diagrams (Ein Beitrag zur Rechnerischen Behandlungen des Dreiphaser-Motordigrammes). O. Weisshaar. An analytical treatment of the data from motor diagrams, with applications to numerical examples. 4000 w. Elektrotech Zeitschr—Nov. 14, 1901. No. 45189 B.

Motors.

The Performance of Electric Railway Motors. George T. Hanchett. Gives an analysis of performance curves and considers their application to the problem of practical selection, believing it to be the only proper way of choosing a railway motor for a given service. 5000 w. St. Ry Jour—Dec. 7, 1901. No. 44835 D.

Navy Yard.

Electricity at the New York Navy Yard. F. N. Kollock, Jr. An illustrated description of the new polyphase power plant. 8800 w. Jour Am Soc of Nav Engrs—Nov., 1901. No. 44641 H.

Pumping Machinery.

The De Kalb Electrical Pumping Plant. D. W. Mead. Illustrated description of a municipal plant in Illinois which has been in successful operation since February, 1895. 3000 w. Munic Engng—Dec., 1901. No. 44756 C.

MISCELLANY.

Address.

Sir William Henry Preece's Address before the Society of Arts. The subject discussed was the great scientific discoveries of the 19th century. 10700 w. Jour Soc of Arts—Nov. 22, 1901. No. 44707 A.

Arresters.

Notes on Lighting and High Voltage Arresters for Electric Currents. J. Wright. Considers how to efficiently protect a building from lightning, and also electric circuits not connected to earth. Ill. 2700 w. Ind & East Engr—Nov, 1901. No. 45036 B.

Electrical Instruments.

Notes on Practical Electrical Instrument making. John C. Bagot. An illustrated article touching on points needing to be understood by instrument makers, that comprehending the effect to be produced, he can manufacture the cause. 1700 w. Elec Engr, Lond—Nov. 22, 1901. Serial. 1st part. No. 44721 A.

Lightning.

Lessons from Lightning Strokes (Blitzschläge und Lehren aus Denselben). F. Neesen. A discussion of the recorded action of lightning strokes and a consideration of possible short circuits and other sources of danger. 1800 w. Elektrotech Zeitschr—Nov. 28, 1901. No. 45198 B.

The Effect of Lightning upon Metallic Structures (Les Constructions Métalliques et la Foudre). A review of the records of skeleton steel buildings which have been struck by lightning, discussing the possible relation between the construction and effect. 1200 w. Revue Technique—Nov. 10, 1901. No. 45110 D.

GAS WORKS ENGINEERING

Acetylene.

Car Lighting by Acetylene Gas on the Avery Acetylite System. Illustrates and describes the apparatus and its connections as used on cars. 900 w. Eng News—Dec. 5, 1901. No. 44797.

Incandescent and Carburetted Acetylene. Reviews a paper presented by Dr. N. Caro, to the German Acetylene Verein. Discusses the difficulties in the way of making a satisfactory burner, and the properties of acetylene. 1200 w. Engr, Lond—Dec. 13, 1901. No. 45044 A.

Coal Handling.

The Mechanical Handling of Coal and Coke (Manutention Mécanique du Charbon et du Coke). J. Laverchère. Describing and illustrating very fully the apparatus used at the gas works of Dijon and of Havre. 2000 w. 1 plate. Génie Civil—Dec. 7, 1901. No. 45105 D.

Exhibition.

The Gas Exhibition at the Crystal Palace. A review of the exhibits. 7700 w. Jour Gas Lgt—Dec. 17, 1901. No. 45072 A.

Gasholders.

Mayer's Improvements in Gasholder Tanks. Illustrations and specifications. The construction is the same as the Intze gasholder save that the Mayer tank is not an annular one. 1200 w. Am Gas Lgt Jour—Dec. 9, 1901. No. 44839.

Gas Plants.

The Efficient Working of Gas Plants for Gas Engines. Joseph Emerson Dowson. From the minutes of Pro. of the Inst. of Civ. Engrs., England. Discusses some of the theoretical and practical considerations which affect the working. 3800 w. Eng News—Dec. 5, 1901. No. 44798.

Gas Producers.

The Action of Various Types of Gas

Producers (Sur l'Action des Divers Types de Gazogènes). A. Lencauchez. With especial reference to the action of producer gas in open-hearth furnaces. 4000 w. Mem Soc Ing Civ de France—Sept., 1901. No. 45120 G.

Generator.

Gas Generator with Reversed Combustion. J. Deschamps, in *Le Genie Civil.* Illustrates and describes an apparatus that has been in use for several months in France for supplying gas motors. 1500 w. Sci Am Sup—Dec. 7, 1901. No. 44770.

High Pressure.

High-Pressure Gas Lighting. Mr. Casmey, before the Manchester and Dist. Junior Gas Assn. Describes the Keith compressor and burner, comparing it with the incandescent and common gas-jet. Discussion. 4000 w. Jour Gas Lgt—Dec. 3, 1901. No. 44888 A.

Illumination.

The Physical Principles of Illumination, with Special Reference to Recent Methods. Douglass Burnett. Presented to the Department of Physics, of the Brooklyn Inst. A review of basic scientific principles, existing methods and future possibilities. 3500 w. Am Gas Lgt Jour—Dec. 23, 1901. No. 45009.

Mantles.

Testing Incandescent Mantles. Abridged rules issued by the German Gas Association. 1000 w. Gas Wld—Dec. 14, 1901. No. 45025 A.

Measurement.

Quick Measurement and Analysis of Gas. Dr. Hugo Strache. Read before the German Gas Assn. Describes the author's developments, the instruments used, etc. 2200 w. Gas Wld—Nov. 23, 1901. No. 44715 A.

Retorts.

Heckmondwick Inclined Retorts and Coal and Coke Plant. Describes a very complete installation and its accompaniments. 3300 w. Jour Gas Lgt—Dec. 10, 1901. No. 44975.

The Economical Advantages of Inclined Retort-Settings. W. R. Herring. An examination of statistics abstracted from "Field's Analysis" and a statement of conclusions. 2500 w. Jour Gas Lgt—Dec. 3, 1901. No. 44886 A.

Wakefield.

The Wakefield Gas-Works. H. Townsend. Read before the Manchester Dist. Inst. of Gas Engrs. History of the gas works, with illustrated description of the inclined retorts. Also discussion. 11200 w. Jour Gas Light—Dec. 3, 1901. No. 44887 A.

Water Gas.

Carburetted Water Gas. From *Le Genie Civil.* An illustrated sketch of this industry. 3300 w. Sci Am Sup—Dec. 14, 1901. No. 44908.

Water-Gas Tar.

Water-Gas Tar for Boiler Heating. Illustrated description of the system as used by the Hodroleum Company. 1800 w. Jour Gas Lgt—Nov. 26, 1901. No. 44812 A.

Wood Gas.

The Riche Wood Gas Process. Illustrated detailed description. 1300 w. Ir & Coal Trds Rev—Nov. 22, 1901. No. 44736 A.

INDUSTRIAL ECONOMICS

Africa.

Need of Direct Steamship Service to Africa. Criticises the methods of American manufacturers in introducing their products where the English language is not understood, explains European methods, and discusses the need of American steamships. 3500 w. U S Cons Repts, No. 1209—Dec. 9, 1901. No. 44774 D.

Alcohol.

Exposition of Motors and Appliances for Utilizing Methylated Alcohol (Concours et Exposition de Moteurs et Appareils Utilisant l'Alcool Denaturé). H. Guérin. An account of the exposition in Paris for the purpose of promoting the industrial applications of alcohol. Two articles. 4000 w. Génie Civil—Dec. 7, 14, 1901. No. 45106 each D.

Competition.

British and American Fuel: Is Competition Possible? Considers the whole problem hinges on the question of freights, and discusses this side of the question in some detail. 3700 w. Ir & Coal Trds Rev—Dec. 6, 1901. No. 44915 A.

The Invasion of British Markets (L'Invasion du Marché Britannique). A report of the French consul M. Jean Perier, concerning the extent to which American products have entered into British trade. Serial, Part I. 3000 w. Revue Technique—Nov. 25, 1901. No. 45116 D.

Exposition.

The Exposition of 1902 in Düsseldorf (Die Austellung in Düsseldorf 1902). E. Dücker. A general description, with views of the buildings as thus far completed. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 23, 1901. No. 45153 D.

Factory Legislation.

The Factory and Workshop Act, 1901. A short account of the whole act, which has recently passed the British Parliament, emphasizing the portions which are new. 5000 w. Engng—Dec. 13, 1901. No. 45038 A.

Industrial Commission.

The Three-Year's Work of the United States Industrial Commission. Samuel M'Cune Lindsay. This commission was established to investigate questions pertaining to immigration, labor, agriculture and business, and to suggest legislation as it deemed best on these subjects. 7000 w. Rev of Revs—Dec, 1901. No. 44705 C.

Industrial Forces.

A New Alignment of Industrial Forces. J. B. Johnson. Discusses the changed attitude of union leaders and trade unionism in general. 2100 w. Am Mfr—Dec. 19, 1901. No. 45008.

Patents.

General Information Concerning Patents for Inventions (Renseignments Généraux Relatifs aux Brevets d'Invention). A tabulated presentation of the essential requirements for patents in 17 important countries of Europe and America. 1200 w. Revue Technique—Nov. 25, 1901. No. 45115 D.

Purchasing.

The Card Index System in the Purchasing Department. F. H. Leland. Describes a card index system adapted to the requirements of the purchasing department of a manufacturing company. 2400 w. Am Mach—Nov. 28, 1901. No. 44643.

Ship Subsidy.

The New Ship Subsidy Bill. Full text of the revised measure as introduced to the Senate of the United States. 2200 w. Naut Gaz—Dec. 12, 1901. No. 44897.

Shop Economics.

Neglected Factors in Machine-Shop Economics. T. S. Bentley. Discussing the importance of providing shop conveniences, the economic value of light and warmth, and the general advantages of system and method in every department. 2500 w. Engineering Magazine—Jan., 1902. No. 45051 B.

Unions.

Employers and Labor Unions. Abstract of an address by Mr. George Gunton before the Manufacturers' Club of Cincinnati. Discusses the relations of the employer and employed, and suggests means of adjusting difficulties. 4200 w. Gunton's Mag—Dec., 1901. No. 44747 C.

Workingmen's Homes.

The Home Environment of British Workingmen. Percy Longmuir. An examination of the important relation which home environment bears to industrial efficiency, and the extent to which deficiencies in this respect act as a handicap to British industries. 3500 w. Engineering Magazine—Jan., 1902. No. 45053 B.

MARINE AND NAVAL ENGINEERING

Armor.

Armor Plate and High Explosive Shells. Illustrations of tests made at Sandy Hook Proving Ground on the powers of defense and attack. 1200 w. Sci Am—Dec. 14, 1901. No. 44905.

Battleships.

I. Battleships "Kearsarge" and "Kentucky." II. Alabama Class—First-Class Battleship "Wisconsin." III. Maine Class —First-Class Battleship "Maine." Illustrated detailed descriptions, with discussion of novel features. 5800 w. Sci Am —Dec. 14, 1901. No. 44902.

Our Latest Design for Battleships. An illustrated description of plans recommended by the Naval Board on Construction. 1200 w. Sci Am—Nov. 30, 1901. No. 44651.

Russian Battleship Kniaz Potemkin Tavritschesky. Illustrated description of the vessel and its armament. 1400 w. Engr, Lond—Nov. 29, 1901. No. 44859 A.

Convention.

The Third Convention of the Society of Marine Architects (Die Dritte Hauptversammlung der Schiffbautechnischen Gesellschaft). A report of the meeting of German Marine Architects held at Charlottenburg, November, 1901. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 30, 1901. No. 45158 D.

Corrosion.

Notes on the Serious Deterioration of Steel Vessels from the Effects of Corrosion. George Johnstone. Lecture delivered at the opening meeting of the Inst. of Engrs. & Shipbuilders in Scotland, 1901. A record of the writer's experience. 3000 w. Naut Gaz—Dec. 19, 1901. No. 45015.

Cruisers.

I. Armored Cruisers of the "Maryland" Class—"California." II. The Semi-Armored Cruisers of the "St. Louis" Class. III. The Sheathed Semi-Protected Cruisers of the "Denver" Class. Illustrated discussion of these vessels, noting features of special interest. 2500 w. Sci Am—Dec. 14, 1901. No. 44906.

H. M. First-Class Cruiser Monmouth. Illustration, with brief description of a recently launched vessel. 700 w. Engr, Lond—Nov. 22, 1901. No. 44746 A.

Destroyers.

Torpedo-Boat Destroyers. Editorial review of a recently issued Parliamentary paper giving information of the various torpedo-boat destroyers which have been built for the British Admiralty. 1600 w. Engng—Nov. 29, 1901. No. 44853 A.

Guns.

Gun Explosions. Discusses briefly the cause of gun accidents. 1900 w. Engr, Lond—Nov. 22, 1901. No. 44743 A.

I. Latest Types of Naval Guns. II. Gun Mounts and Breech Mechanisms. Illustrated detailed descriptions of the guns and their action. 2000 w. Sci Am—Dec. 14, 1901. No. 44904.

Lake Steamer.

Lake Steamer Captain Thomas Wilson. An illustrated description of a single deck bulk cargo steamer and its equipment. 1500 w. Marine Engng—Dec., 1901. No. 44866 C.

Lightships.

Recent Improvements in the Lighting and Buoying of the Coasts of France. Baron Quinette de Rochemont. Extract from a paper read before the Glasgow Congress. Describes the "Sandettie" lightship and accessories. 1400 w. Marine Engng—Jan., 1902. No. 45252 C.

Mercantile Marine.

The French Mercantile Marine. A statement of the decadence and present condition, and the difficulties in the attempts at revival. 2900 w. Engr, Lond—Dec. 6, 1901. No. 44920 A.

Monitors.

"Arkansas" Class—The Monitor "Arkansas." Illustrated description, with comments. 1200 w. Sci Am—Dec. 14, 1901. No. 44903.

Navy Yard.

See Electrical Engineering, Power Applications.

Oil Transportation.

The Carriage of Oil in Bulk. Describes the steamship Clam, one of a fleet of vessels used in the oil-carrying trade. The boilers are worked with oil instead of coal. The boat contains a number of well holds, and is capable of stowing away 4500 tons of oil. Some of the vessels will hold 11,000 tons. The vessels can be so cleansed as to carry the most delicate cargoes without taint. 1400 w. Engr, Lond—Dec. 6, 1901. No. 44926 A.

River Steamer.

Light-Draft River Steamer. Illustration and description of the Thomas A. Edison, built for service on the Caloosahatchee in Florida. 800 w. Naut Gaz—Dec. 12, 1901. No. 44896.

Schooners.

The Mechanical Equipment of Modern Schooners. B. C. Tuthill. The Geo. W. Wells is illustrated and described as a type of the large six-masted schooners, the method of fitting out being practically the same in the latest built schooners of large size. 1500 w. Marine Engng—Jan., 1902. No. 45250 C.

Shipbuilding.

The Works of the New York Shipbuilding Company. Illustrated detailed description of this fine plant on the Delaware River, opposite Philadelphia. 4500 w. Marine Engng—Dec., 1901. No. 44864 C.

Ship Subsidy.

See Industrial Economics.

Stability.

Stability of Ships. Theodore Incas. Discusses methods of measuring the stability, means of increasing the leverages, as well as the range of the stability, etc. Ill. 2200 w. Naut Gaz—Dec. 5, 1901. No. 44810.

Steamship.

Express Steamship La Savoie. Illustrated description of a fine new ship recently placed in service between New York and Havre. 900 w. Marine Engng—Dec., 1901. No. 44865 C.

Torpedo Boats.

I. The Holland Submarine Torpedo Boat Class. II. Torpedo Boats and Destroyers. Illustrated discussions with descriptions. 1700 w. Sci Am—Dec. 14. 1901. No. 44907.

U. S. Navy.

Our Naval Development Since the War with Spain. Description and illustrations of ships commissioned, completed or under construction since the war. Also editorial. 1500 w. Sci Am—Dec 14, 1901. No. 44901.

Warships.

The Gun Power of Warships. Editorial discussion of the increase in gun power and the placement of the guns. Compares British and American practice. 1800 w. Engng—Nov. 22, 1901. No. 44741 A.

Wharf Cranes.

The Development of Shipyard Crane Service. Henry P. Jones. An illustrated discussion of those cranes used in carrying on the work at the fitting-out wharf. 2500 w. Eng News—Nov. 28, 1901. No. 44656

MECHANICAL ENGINEERING

AUTOMOBILES.

Boilers.

Automobile Boilers. Joseph W. Jones. States the principal requirements of a carriage boiler, and discusses the design and recent improvemnts. 2300 w. Horseless Age—Dec. 18, 1901. No. 44969.

Celebration Run.

The Celebration Run to Southsea. An illustrated account of the run made to celebrate the sixth anniversary of the passing of the Locomotive on Highways Act, 1896, in England. 5800 w. Autocar—Nov. 23, 1901. No. 44712 A.

Cycle Shows.

The Cycle Shows. Comments on the exhibits, and the tendency toward mechanical propulsion. Describes some of the most interesting cycles. 2500 w. Engng—Dec. 6, 1901. No. 44932 A.

Electric Power.

Electric Automobiles—Long Runs on One Charge. Henry F. Joel. An examination of some of the record or limit runs. 2000 w. Elec Rev, Lond—Nov. 22, 1901. No. 44726 A.

Engine.

The Stearns Compound Engine. Sectional view and description of the engine used on carriages manufactured in Syracuse, N. Y. 700 w. Horseless Age—Nov. 27, 1901. No. 44671.

Exhibits.

The National and Stanley Shows. Brief Illustrated descriptions of special features in the exhibits of motor cars, motor bicycles and their accessories. 4400 w. Auto Jour—Dec., 1901. No. 45071 A.

French Models.

General Characteristics of French 1902 Models. L. D. Makes a classification of the pleasure vehicles and investigates each class. 2800 w. Horseless Age—Dec. 4, 1901. Serial. 1st part. No. 44766.

Gasoline Motors.

Why Gasoline Motors Stall by Overheating. A. M. Herring. Discusses this subject and the methods of overcoming the trouble. 1200 w. Horseless Age—Dec. 18, 1901. No. 44967.

Hill Climbing.

The Gaillon Hill-Climbing Trials. An account of the annual trials in France, where seventy vehicles competed. Ill. 1600 w. Autocar—Nov. 23, 1901. No. 44711 A.

Military Vehicles.

Competition for Military Traction in Great Britain. A copy of the regulations governing a competition to be held in the spring of 1903. 2000 w. U S Cons Repts, No. 1211—Dec. 11, 1901. No. 44814 D.

Military Lorries. An account of the opening proceedings of the trials of self-propelled lorries for military purposes, with illustrated description of the Thornycroft vehicles. 3800 w. Engng—Dec. 6, 1901. No. 44930 A.

The Military Self-Propelled Wagon Trials. Illustrates and describes the wagon and trailer of the Straker Steam Vehicle Co. and other vehicles. 700 w. Engng—Dec. 13, 1901. No. 45037 A.

War Office Heavy Motor Vehicle Trials. Gives details of specifications supplied by the manufacturers entering vehicles. Ill. 4500 w. Auto Jour—Dec., 1901. No. 45070 A.

Motor Cycle.

Colonel Holden's Motor Bicycle. Detailed drawings and description of the most recent form of this machine. 2400 w. Auto Jour—Dec., 1901. No. 45069 A.

The Evolution of the Motor Cycle. Hrolf Wisby. Illustrates and describes developments of this machine. 1800 w. Sci Am—Dec. 21, 1901. No. 44974.

Speed Records.

New Automobile Speed Records. An account of the speed tests on Ocean Parkway, Brooklyn, on Nov. 16, 1901, with illustration of the automobile that made a mile in 63 seconds. 800 w. Sci Am—Nov. 30, 1901. No. 44652.

Stages.

A Novel Method of Motor Traction. Illustrated description of a system described by Herr Max Schiemann in the *Elektrotechnische Zeitschrift.* The novelty consists in supplying energy to the motor cars from trolley wires, though no tracks are provided. 900 w. Elec Engr, Lond—Dec. 13, 1901. No. 45028 A.

Electric Automobile Stages in New York City. Illustrates and describes the vehicles in service on Fifth avenue, New York. 1300 w. Elec Wld & Engr—Dec. 14, 1901. No. 44955.

Motor Vehicles with Overhead Trolley and without Track (Gleislos Motorbahnen mit Elektrischem Oberleitungs antrieb). Max Schiemann. An illustrated description of a motor omnibus system suitable for small villages as a preliminary to the establishment of tramways. 2000 w. Elektrotech Zeitschr—Nov. 21, 1901. No. 45192 B.

Steering.

The Demand for Improved Wheel Steering Devices. Hugh D. Meier. Describes various devices in use, discussing their defects. 900 w. Horseless Age—Dec. 18, 1901. No. 44968.

Tires.

Multiple Tires: A Query. Albert L. Clough. Describes a model of a "new and improved" wheel shown the writer, and discusses its possible advantages and disadvantages. 1000 w. Horseless Age—Dec. 11, 1901. No. 44945.

Trials.

The Principal Automobile Trials of the Year (Les Principals Epreuves Automobiles de l'Année). A review with tabulated data and results of the principal automobile trials in France in the year 1901. 3500 w. Génie Civil—Dec. 14, 1901. No. 45108 D.

Vibration.

The Vibration Automobiles (Les Trépidations dans les Voitures Automobiles). F. Drouin. Discussing the effects of inertia and the arrangement of cylinders, showing how the vibration may be reduced to a minimum. Two articles. 4000 w. Génie Civil—Dec. 7, 14, 1901. No. 45107 each D.

HYDRAULICS.

Flow.

A Proposed Solution of Some Hydraulic Problems. Charles H. Tutton. An attempt to solve determinately the question why the maximum velocity is found below the surface in channels. 6600 w. Pro Am Soc of Civ Engrs—Nov., 1901. No. 44683 E.

Experiments at Detroit, Mich., on the Effect of Curvature upon the Flow of Water in Pipes. Continued discussion of paper in this subject by Gardner S. Williams, Clarence W. Hubbell, and George H. Fenkell. Ill. 15000 w. Pro Am Soc of Civ Engrs—Nov., 1901. No. 44687 E.

Rational and Empirical Features of Flow of Water in Pipes. Letter from Mr. Clemens Herschel to Mr. I. P. Church, commenting on an article published Oct. 31, and Mr. Church's reply. 2300 w. Eng News—Dec. 19, 1901. No. 44985.

Plumbing.

Plumbing in the Park-Realty Building, New York. Illustrates and describes the work in an 80 x 100-ft. 12-story family hotel. 1300 w. Eng Rec—Dec. 7, 1901. No. 44823.

Pump.

The Schleifmühle High Speed Pump (Die Expresspumpe Schleifmühle). H. Ehrhardt. An account of the performance of this improved electrically driven deep mine pump. The valves are not mechanically operated. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 16, 1901. No. 45151 D.

Pumping Machinery.

Experiences in Reducing Water Ram Caused by Direct-Acting Pumping Engines. George E. Winslow. An account of an experience of the writer with water ram at the water works of Waltham, Mass. 3000 w. Jour N Eng Water Wks Assn—Dec., 1901. No. 44882 F.

Hydraulic Pumping Machinery. Fr. Frolich. Abstract of a paper read before the Society of German Engineers, at Witten. States the advantages of hydraulic pumping plants giving illustrated descriptions of plants built by Berliner Maschinenbau Actien-Gesellschaft. 2400 w. Engng—Dec. 6, 1901. Serial. 1st part. No. 44938 A.

See Electrical Engineering, Power Applications.

Scoop Wheel.

Test of a Scoop Wheel (Beproeving van een Scheprad). J. C. Dijxhoorn. Describing the Paul scoop wheel for raising large volumes of water against a low lift, with data and results of tests, showing an efficiency of 59 per cent. 2500 w. De Ingenieur—Nov. 16, 1901. No. 45205 D.

Velocity Measurements.

Current Meter and Weir Discharge Comparisons. Discussion of paper by Edward C. Murphy. 2600 w. Pro Am Soc of Civ Engrs—Nov., 1901. No. 44684 E.

Water-Wheel.

A "Tangential" Impact Water Wheel. Illustrates and describes a new style of impulse wheel. 1200 w. Eng News—Dec. 12, 1901. No. 44891.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

Ball Bearings (Kugellager), F. Heerwagen. An examination of the rolling conditions in various forms of ball bearings, with especial reference to the pressure and wear. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 30, 1901. No. 45154 D.

Bearings.

Radial Machine Bearings. J. Richards. An illustrated article discussing the influence of design upon their wearing qualities. 1500 w. Mach, N. Y.—Dec., 1901. No. 44776.

Brace Pins.

On the strength of Brace Pins. Considers the different modes of failure, and gives a solution of a problem submitted. 2000 w. Prac Engr—Dec. 13, 1901. No. 45024 A.

Brakes.

Theory and Design of Mechanical Brakes. E. R. Douglas. Mathematical demonstration. 1500 w. Am Mach—Dec. 19, 1901. Serial. 1st part. No. 44979.

Centrifugal Force.

Centrifugal Force Diagrams. P. Muller. Gives diagrams constructed to obtain the rim tension per square inch for a given metal in one reading at any radius or speed, without having to resort to laborious calculations. 400 w. Am Mach—Nov. 28, 1901. No. 44646.

Cranes.

See Electrical Engineering, Power Applications.

Crank Pins.

Care and Repair of Crank Pins. Suggestions for methods of keying, repairing, etc. 2500 w. Power—Dec., 1901. No. 44960.

Dies.

An Improved Dial Feed Armature Disk Die. Joseph V. Woodworth. Illustrated description of die and attachments which can be used on any simple-acting power press to which a connecting rod for operating the feed can be connected. 900 w. Am Mach—Dec. 19, 1901. No. 44980.

Blanking, Drawing and Half-Wiring. William Doran. Illustrates and describes a combination die. 1400 w. Am Mach—Dec. 19, 1901. No. 44978.

Drawings.

A Decimal System for Numbering Working Drawings. Henry L. Hutson. Describes a system similar to the Dewey Decimal System used for numbering books in libraries. Also editorial. 2000 w. Am Mach—Dec. 26, 1901. No. 45061.

Drilling.

A High Speed and Two Tapping Attachments for Drillers. Herman Isler. Illustrated description. 600 w. Am Mach —Nov. 28, 1901. No. 44647.

Deep Hole Drilling. A collection of useful data covering both large and small work, with illustrations. 4800 w. Mach, N. Y.—Dec., 1901. No. 44775.

Electric Driving.

See Electrical Engineering, Power Applications.

Elliptic Lathe.

Elliptic Lathe with Movable Tool (Tours Elliptiques à Outil Guidé). Ch. Dantin. With especial reference to the lathe of MM. Vrignault & Brosse for turning elliptical forms. 2000 w. Génie Civil —Nov. 30, 1901. No. 45104 D.

Equipment.

The Engineer in the Foundry: A New Departure. An illustrated article prepared from the lecture of Samuel Groves, at the Buffalo convention of the Am. Found. Assn. showing the methods pursued in providing foundry appliances and equipment for the works of the Westinghouse Machine Co. 2800 w. Foundry—Dec., 1901. No. 44655.

Lathes.

A Lathe Shown at the Pan-American. Illustrated account of the work of Tahar Ben Mh. of Tunis, and his tools. 600 w. Am Mach—Dec. 26, 1901. No. 45062.

Capstan Lathe. Illustrates and describes a new tool exhibited at the National Cycle Show, especially adapted for high-speed work. 900 w. Engng—Dec. 13, 1901. No. 45040 A.

Machine Tools.

Improved Planing and Shaping Machines (Neuere Hobel und Stossmachinen). P. Janzon. Illustrating the heavy planer built by the Berlin Machine Tool Works. The bed is driven by a pair of longitudinal screws. Serial, Part I. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 16, 1901. No. 45148 D.

Machine Tools and Their Use in Locomotive Works. A supplement giving many illustrated descriptions of machines and explaining how they are used. 19300 w. Engr, Lond—Dec. 13, 1901. No. 45045 A.

Machine Tools at the Glasgow Exhibition. Fred. Bathurst. An illustrated article with special reference to the requirements of dynamos and motor manufacture. 2500 w. Elec Rev, Lond—Nov. 22, 1901. Serial. 1st part. No. 44724 A.

Machine Tools at the National Show. Illustrations of screw machine, and shaving lathe, with description of these and other exhibits. 2700 w. Engng—Dec. 6, 1901. No. 44928 A.

Machine Tools at the Stanley Show. Illustrates and describes tools of special interest. 4200 w. Engng—Nov. 29, 1901. No. 44851 A.

Speed of Machine Shop Tools. J. W. E. Littledale. Read before the Northern Coast Inst. of Engrs. & Shipbuilders. Suggestions tending to improve the results of out-of-date tools, as well as the proper working of new tools. 4000 w. Ir Trd Rev—Dec. 26, 1901. No. 45064.

Supplementary Report on Machine Tools at the Paris Exposition 1900 (Nachtrag zum Bericht über die Werkzeugmaschinen auf der Weltausstellung in Paris, 19 Hermann Fischer. Describing special forms of turret lathes and milling machines. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 7, 1901. No. 45161 D.

The Guest Universal and Cutter Grinder. Illustrated description of a tool designed to accurately and rapidly do the grinding required in manufacturing establishments.

explaining its operation. 1800 w. Engng—Dec. 6, 1901. No. 44931 A.

Machinery.

Machining Drill Columns. William Doran. Illustrates tools and describes their use. 1000 w. Am Mach—Dec. 12, 1901. No. 44877.

Melting.

Melting Loss in the Cupola Process. Tabulated information reported to the American Foundrymen's Association. 1000 w. Jour Am Found Assn—Dec., 1901. No. 44755.

Molding.

Molding a Large Cross Pipe. Illustrated description of the method used. 1000 w. Am Mach—Dec. 5, 1901. No. 44771.

Pipe Making.

The Manufacture of Locking-Bar Pipes in Western Australia. Stafford Ransome. Illustrates and describes the making of the Ferguson locking-bar water pipe at Falkirk, Western Australia. 2400 w. Engr, Lond—Nov. 29, 1901. No. 44858 A.

Pistons.

Centering a Piston. H. H. Kelley. Explains why the piston should occupy a perfectly central position, the tools necessary, and the method of doing the work. Ill. 2100 w. Mod Mach—Dec., 1901. No. 44806.

Piston Valves.

Locomotive Piston Valve. Discussion of this subject introduced by Mr. John Player. 6800 w. Cent Ry Club—Nov., 1901. No. 44804 C.

Polishing.

A Polishing Arrangement for Gold and Silver, and the Collecting of the Dust. Describes a system used in polishing jewelry. 600 w. Am Mach—Dec. 26, 1901. No. 45063.

Rack Shaper.

The Fellows Rack Shaper. Illustrated description. 700 w. Am Mach—Nov. 28, 1901. No. 44644.

Roller Bearings.

Further Comparisons of Roller Bearings. Thomas W. How. Presents the requirements of satisfactory roller bearings and results obtained. 3800 w. Tram & Ry Wld—Nov. 14 1901. No. 44753 B.

Shop Economics.

See Industrial Economics.

Shops.

The Ventilation, Lighting and Cleanliness of Small Workshops. John Robertson. Discusses the proper sanitation of such shops. 3000 w. Plumb & Dec—Dec. 2, 1901. No. 44889 A.

Spiral Gearing.

Spiral Gears Set at 90 Degrees. John Randol. Discusses the advantages of spiral gears, and gives a very simple diagram by aid of which they can be cut with ordinary cutter. Ill. 2800 w. Am Mach—Dec. 5, 1901. No. 44773.

Steel Works.

The Barrow-Hematite Steel Works. Arthur J. While. Read at Barrow meeting of the Inst. of Mech. Engrs. Illustrated detailed description of the works and their equipment. 2300 w. Engng—Nov. 22, 1901. No. 44740 A.

Tools.

Some Special Turret Head Tools. Joseph V. Woodworth. Illustrates and describes tools for making small tubes used for perforating leather shoe tips. Also a tool for pointing slender needle valves on an incandescent oil lamp. 600 w. Am Mach—Dec. 5, 1901. No. 44772.

MATERIALS OF CONSTRUCTION.

Nickel-Steel.

Nickel Steel (L'Acier au Nickel). Discussing the toughness and ductility imparted to steel by various proportions of nickel. 2000 w. Revue Technique—Nov. 25, 1901. No. 45114 D.

Testing.

The Congress of the Association for Testing Materials at Budapest, September, 1901 (Le Congrès des Méthodes d'Essai Tenu à Budapest au Mois de Septembre, 1901). A. Pourcel. A general abstract of the proceedings of the section for testing metals. 2500 w. Génie Civil—Nov. 23, 1901. No. 45101 D.

Wire.

The Permanent Deformations of Metallic Wires (Déformations Permanentes des Fils Métalliques). Giving the results of tests by M. Lenoble, of Lille, showing the behaviour of wire under varying loads. 1200 w. Revue Technique—Nov. 10, 1901. No. 45109 D.

POWER AND TRANSMISSION.

Belt Transmission.

Horse Power Transmitted by Belts and Gears, and Diagrams for Obtaining Belt Dimensions. Robert A. Bruce. Gives a diagram for showing graphically the relations which exist between the horse power, the linear speed, and the effective tension or pressure on teeth, in the case of belt or gear transmissions, with directions for the use of the diagram. 1300 w. Prac Engr—Nov. 29, 1901. Serial, 1st part. No. 44-847 A.

The Efficiency of High Speed Belts (Die Arbeitsleistung Schnellaufender Riemen). Dr. H. Abbes. An examination of the influence of speed on belt efficiency with a view of determining the best belt speed. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 16, 1901. No. 45149 D.

Clutches.

Clutches (Les Embrayages). M. Enverte. The first installment of an elaborate detailed treatise on clutches and couplings of all sorts. The present portion treats of classification. 5000 w. Revue de Mécanique—Nov. 30, 1901. No. 45141 E + F.

Coal Handling.

Coal-Conveying Plant at Edinburgh (McDonald Road) Electricity Works. Brief illustrated description. 1200 w. Elect'n, Lond—Dec. 13, 1901. No. 45026 A.

Modern Coal Handling Machinery. Waldon Fawcett. Reviews the great development in this field during the last ten years. Ill. 2000 w. Am Mfr—Aug. 22, 1901. No. 44698.

Gearing.

Concerning Toothed Gearing (Ueber Zahnräder). Alois Schaffer. A mathematical examination of the action of cycloidal and involute gear teeth. Two articles. 9000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 22, 29, 1901. No. 45169 each B.

Hydro-Electric Plants.

See Electrical Engineering, Power Applications.

Pneumatic Distribution.

A Pneumatic Tube System of Parcel Distribution in Boston. Edward D. Sabine. Illustrated description of this recently constructed line and its operation. 1200 w. Eng News—Dec. 5, 1901. No. 44794.

Power Cost.

The Cost of Power for Small Plants. W. H. Wakeman. Discusses the conditions that affect cost and gives data that will enable those interested to make comparisons of fuel costs. 2000 w. Mod Mach—Dec., 1901. No. 44807.

Power Plant.

Description of the Steam Engineering Plant at the Navy Yard, New York. C. H. Matthews. An illustrated description of the new buildings and their equipment. 2700 w. Jour Am Soc of Nav Engrs—Nov., 1901. No. 44639 H.

New Power Plant of the National Cash Register Company. Illustrated description of the new steam plant recently built. 1200 w. Eng Rec—Nov. 30, 1901. No. 44661.

Power Plant of a New Sulphite Mill. Illustrated description of a recent installation of steam power equipment in a sulphite mill at Lockport, N. Y. 3000 w. Engr, U. S. A.—Dec. 1, 1901. No. 44759.

Variable Speed.

Bicycle Differential Gears. From *La Nature*. Illustrated description of various systems. 1800 w. Sci Am Sup—Dec. 21, 1901. No. 44973.

SPECIAL MOTORS.

Alcohol Motors.

Exposition of Motors and Apparatus for Utilizing Methylated Alcohol (Concours et Exposition de Moteurs et Appareils Utilisant l'Alcool Dénaturé). G. Coupan. Describing the exhibits and giving fully tabulated data and results of tests of motors. 2500 w. Génie Civil—Nov. 30, 1901. No. 45102 D.

The Exposition of Apparatus for Utilizing Methylated Alcohol (L'Exposition des Appareils Utilisant l'Alcool Dénaturé). H. Pouleur. A review of the motors and the warming and lighting apparatus exhibited at Paris, Nov., 1901. 3500 w. Rev Univ des Mines—Nov., 1901. No. 45128 H.

Gas Engines.

A Note on the Computations for Gas Engines (Beitsag zur Berechnung der Gasmaschine). R. Barkow. A mathematical investigation of the forces acting in a gas engine as deduced from the indicator diagram. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 16, 1901. No. 45150 D.

Design for a I. H. P. Gas Engine. J. C. Brocksmith. Description and working drawings of a gas engine to develop continuously one brake horse-power at the moderate speed of 500 r. p. m. Especially designed for electrical work. 3700 w. Am Elect'n—Dec., 1901. No. 44789.

Point of Ignition and I. H. P. in Gas Engines. Charles E. Lucke. An account of tests made to find some of the relations between the varying point of ignition and the resulting work area or indicated horsepower. 2000 w. Horseless Age—Dec. 4, 1901. No. 44765.

Gasoline Motors.

See Mechanical Engineering, Automobiles.

Heat-Engine.

The Heat-Engine Problem. Charles E. Lucke. Gives a review of the cycles in which heat engines may work, and decides that only the Brayton and the Otto are available in practice. Gives the requirements of a proper apparatus and the results of a series of experiments to devise such an one. Ill. 1500 w. Trans Am Soc of Mech Engrs, No. 926—Dec., 1901. No. 44846 C.

STEAM ENGINEERING.

Boilers.

Boiler Tests. J. Rowland Brown. Considers the different kinds of boiler tests—

for capacity, for efficiency, defects, fuel economy, design, operation, etc., and the importance of knowing the conditions under which the test was made. 4200 w. Engr, U. S. A.—Dec. 1, 1901. No. 44760.

On the Use of Zinc in Boilers. R. A. Douglass. Considers cases where zinc is useful and precautions to be taken when using it. 1000 w. Am Elect'n—Dec., 1901. No. 44786.

See Mechanical Engineering, Automobiles.

Chimneys.

A 108-Foot Concrete Steel Chimney. Illustrates and describes a chimney built in Jersey City, according to the Ransome system, which employs cold-twisted square steel bars to reinforce the concrete. 1400 w. Eng Rec—Nov. 30, 1901. No. 44663.

Brick Chimneys for Power Stations. William D. Ennis. Discussion of the design and construction. Ill. 2500 w. Am Elect'n—Dec., 1901. No. 44785.

Some Interesting Features of Recent Chimney Construction. Illustrates and describes three large chimneys of steel, each of which has interesting features, and also a concrete steel chimney. 3500 w. Eng News—Dec. 19, 1901. No. 44981.

The New Stack of the Prudential Building, Newark, N. J. Illustrated description of a chimney 231-ft. high, built independent of but closely adjacent to a tall office building. 900 w. Eng Rec—Dec. 14, 1901. No. 44938.

Comparative Practice.

English, American, and Continental Steam Engineering. Philip Dawson. Mr. Dawson's third paper discusses Continental practice, giving illustrations of numerous important power plants in various parts of Europe. 4500 w. Engineering Magazine—Jan., 1902. No. 45050 B.

Compound Engine.

500 Horse-Power Compound Engine and Electric Generator. An example of a British-built engine, on the lines as laid down by American practice, for the generating of electric energy for tramway purposes. Illustrated description. 900 w. Engng—Nov. 22, 1901. No. 44738 A.

New Standard Three-Cylinder Compound Engine. Illustrated description of an engine designed for high speeds, uniform turning moment, and efficiency under varying conditions of load. 1400 w. Elec Rev, Lond—Nov. 22, 1901. No. 44725 A.

Condenser.

Evaporative Condenser of 4500 Horse Power (Aérocondenseur de 4500 Chevaux). F. Fouché. Illustrated description of a large evaporative surface condenser erected at Kalgoorlie, Western Australia. 4000 w. Mem Soc Ing Civ de France—Oct., 1901. No. 45121 G.

Dry Steam.

Talk on Dry Steam and Steam Separators. James Bonar. Recommends the use of separators, discussing their utility, and points in their selection and location. 1400 w. Am Mfr—Dec. 12, 1901. No. 44946.

Engines.

See Mechanical Engineering, Automobiles.

Explosion.

Boiler Explosion at the Penberthy Injector Co., Detroit, Mich. Illustrated account of the disaster. 900 w. Eng News—Dec. 19, 1901. No. 44986.

Feed Water.

The Purification of Boiler Feed Water. Abstract from the memorandum of C. E. Stromeyer, presented at the annual general meeting of the Manchester Steam Users' Assn. Discussion of water softeners is commenced in the present article. 2700 w. Prac Engr—Nov. 22, 1901. Serial. 1st part. No. 44714 A.

The Solubility of Sulphate of Lime. (Etude sur la Solubilité du Sulfate de Chaux). M. Boyer-Guillon. A review of the careful experiments of the author, showing the relations between temperature of feed water and the presence of dissolved sulphate of lime. 3500 w. Revue de Mécanique—Nov. 30, 1901. No. 45140 E+F.

Water Softening and Purifying. P. A. G. Bell. Read before the West of Scotland Iron & Steel Inst. Describes the Bell system of water purification. Explaining the principles involved and the method of working. 5200 w. Ir & Coal Trds Rev—Nov. 29, 1901. No. 44855 A.

Heating.

Indirect Steam Heating in a Residence. Illustrates and describes a system recently installed in the house of Charles Scribner, New York. 1400 w. Eng Rec—Dec. 14, 1901. No. 44941.

Heating and Ventilating.

Ventilation of an Office Building in Hartford. Illustrated description of one of the few plants for positively ventilating large office buildings. Direct-indirect radiation and a plenum system of ventilation are employed. 400 w. Eng Rec—Dec. 21, 1901. No. 45001.

Indicator Diagrams.

The Accuracy of Indicator Diagrams (Zur Genauigkeit der Indikatordiagramme). L. C. Wolff. Discussing the sources of error in indicator diagrams, and the methods of calibration and correction. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 14, 1901. No. 45164 D.

Jacketing.

Jacketing of Steam Cylinders. Editorial reviewing investigations in this field and giving suggestions for preventing loss of heat from cylinder condensation. 1500 w. Loc Engng—Dec., 1901. No. 44694 C.

Lubrication.

The Oil Supply in Crank Cases of Inclosed Engines. Hugh D. Meier. Considers ways of accomplishing the desired results. 700 w. Horseless Age—Dec. 18, 1901. No. 44970.

Mechanical Plant.

Mechanical Installation in the Modern Office Building. Reginald Pelham Bolton. Discussion of paper by Charles G. Darrach. 6800 w. Pro Am Soc of Civ Engrs—Nov., 1901. No. 44685 E.

Power, Ventilation and Heating in the Colonial Building, Boston. A ten-story structure in which the four lower stories and basement are used as a theatre, and the remaining stories as an office building. Many interesting features are described. Ill. 3500 w. Eng Rec—Nov. 30, 1901. No. 44665.

Pipe Covering.

Test of Pipe Covering. George H. Barrus. Made before mach. engrs. and others at the Manhattan Ry Power House, N. Y., on Nov. 12, 1901. An account of tests made, giving results. 2800 w. Am Mfr—Dec. 5, 1901. No. 44805.

Powdered Coal.

Two Recent Systems for Burning Powdered Coal. Illustrates and describes the cyclone pulverizer system and the aeropulverizer system. 1500 w. Eng News—Nov. 28, 1901. No. 44660.

Shaft-Governor.

Evolution of the Shaft Governor. Prof. R. C. Carpenter. Paper at meeting of the Engine Builders' Assn. Discusses the various forms of shaft governor and their method of action. General discussion. 9300 w. Engr, U. S. A.—Dec. 16, 1901. No. 44957.

Steam Pipes.

Transverse Stresses in Steam Pipes. A. S. Mann. Discusses the relative length of various mains and branches. 1800 w. Am Elect'n—Dec., 1901. No. 44788.

Steam Power.

Steam Power Generation. G. Croydon Marks. A review of the earliest attempts at the generation of steam power. Ill. 1600 w. Prac Engr—Nov. 22, 1901. Serial. 1st part. No. 44713 A.

Stoking.

A Large Boiler Stoking Plant. A large plant in Glasgow is illustrated and described in detail. It supplies sixteen boilers and is capable of dealing with thirty tons of coal per hour. 1800 w. Engr, Lond—Dec. 6, 1901. No. 44925 A.

Thermal Conductivity.

The Transfer of Heat from Steam to Water Through a Partition. H. L. Hepburn. A report of experimental investigations. 3300 w. Power—Dec., 1901. No. 44959.

Turbines.

Tests of the De Laval Turbine (Versuche an einer de Laval Dampfturbine). E. Lewicki. Especially comparing the results with saturated and with superheated steam, showing the advantage of the latter. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 20, 1901. No. 45157 D.

The Future of the Steam Turbine. W. E. Warrilow. A review of the advantages of the turbine over the reciprocating engine, with special reference to electric generating stations. 1200 w. Elec Rev, Lond—Nov. 15, 1901. No. 44811 A.

The Steam Consumption of the De Laval Steam Turbine (Dampfverbrauchsversuche mit de Lavalschen Dampfturbinen). A. Schmidt. Giving data and results of a careful test, showing a total steam consumption of 15.37 pounds per brake horse power, including the air pump resistance. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 23, 1901. No. 45152 D.

Valves.

Piston, Corliss, and Double-Beat Valves. Translation of a lecture by M. Vanderstegen, delivered at Ghent. States why the Corliss and double-beat valves have been abandoned in favor of piston valves. 2800 w. Engr, Lond—Dec. 6, 1901. No. 44927 A.

Valve Gears.

Improved Valve Gears for Steam Engines (Neuere Steuerungen für Dampfmaschinen). H. Dubbel. Illustrating recent automatic valve gears for Corliss and poppett-valve engines. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 30, 1901. No. 45156 D.

MISCELLANY.

Aeronautics.

Graphical Method of Studying the Path of a Dirigible Balloon (Méthode Graphique Permettant d'Etudier la Marche d'un Aerostat Dirigible). J. Armengaud. With diagrams showing the method of determining the path by the projection on the surface of the earth. 1200 w. Comptes Rendus—Nov. 25, 1901. No. 45132 D.

The Determination of the Speed of Dirigible Balloons (Méthode Permettant de Determiner la Vitesse Propre des Aerostats Dirigibles). H. Deslandres. Developing a mathematical formula and applying it to the experiments of Santos-Dumont. 1200 w. Comptes Rendus—Dec. 9, 1901. No. 45137 D.

The Engineer and the Problem of Aërial

Navigation. George W. Melville. Considers that there is no basis for hoping the balloon or flying-machine will ever prove a commercial success. 4800 w. N Am Rev—Dec., 1901. No. 44706 D.

The Path of the Balloon of Santos-Dumont on October 19 (La Trajectoire sur le Sol de l'Aerostat Dirigible de M. Santos-Dumont dans l'Epreuve der 19 Octobre). J. Armengaud. An examination of the successful attempt for the Deutsch prize, with map of the route. 1200 w. Comptes Rendus—Dec. 9, 1901. No. 45,-138 D.

Agricultural Machinery.

Agricultural Machinery and Tools (Die Landwirtschaftlichen Maschinen und Geräthe). H. Grundke. An illustrated review of the agricultural machinery and appliances exhibited at the Paris exposition, 1900. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 30, 1901. No. 45155 D.

Beams.

Experiments on the Flexure of Beams—Discovery of New Laws. Albert E. Guy. Describes experiments undertaken by the writer in which he discovered some laws which had escaped investigation. 2500 w. Am Mach—Dec. 12, 1901. Serial. 1st part. No. 44876.

Coining Machinery.

Minting Machinery and Appliances. Edwin S. Church. An outline of the mechanical operations involved in the coinage of money, with a brief description of the various electrical installations. Ill. 4000 w. Jour Fr Inst—Dec., 1901. No. 44,-843 D.

Combustion.

Shimer's Combustion Apparatus. Report of the Franklin Institute on the improved crucible device of P. W. Shimer, to whom was awarded the John Scott Legacy medal and premium. 900 w. Jour Fr Inst—Dec., 1901. No. 44845 D.

Decoration.

The Decorating of Sheet Steel Painted Ware by Machine Methods. Horace E. Whitney. Describes a method where the labor is decreased and the quality and character of the design raised to a higher standard. 3800 w. Ir Age—Dec. 26, 1901. No. 45003.

Fire Prevention.

The Berlin Exposition for Fire Protection Appliances, 1901 (Die Internationale Austellung für Feuerschutz und Feuerrettungswesen in Berlin, 1901). Kaemmerer & Meyer. Illustrating and describing numerous forms of fire engines and other appliances. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 7, 1901. No. 45,-159 D.

Fulton.

Robert Fulton. Address of Admiral George W. Melville at the unveiling of the memorial erected by the American Society of Mechanical Engineers. 3800 w. Ir Age—Dec. 12, 1901. No. 44871.

Graphics.

The Theory and Application of Graphical Computations (La Theorie et Applications de la Nomographie). Rodolphe Soreau. A discussion of the methods of constructing diagrams for the rapid computation of engineering data, with numerous examples. 1200 w. Mem Soc Ing Civ de France—August, 1901. No. 45117 G.

Low Temperatures.

The Production and Maintenance of Low Temperatures (Production et Maintien des Basses Températures). M. d' Arsonval. A discussion of the uses of solidified carbonic acid, of acetylene snow, and of liquid air. 1200 w. Comptes Rendus—Dec. 9, 1901. No. 45136 D.

Mechanics.

The Conservation of Energy from the Standpoint of the Engineer (Die Erhaltung der Energie vom Standpunkt des Ingenieurs). An examination of the manner in which mechanical energy is transformed in the course of various engineering operations. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 7, 1901. No. 45162 D.

Metric System.

Historical Sketch of the Foundation of the Metric System. M. Bassot. Translated from the Annuaire pour l'an 1901 publie par le Bureau des Longitudes, Paris. 9800 w. Sch of Mines Qr—Nov., 1901. No. 44964 D.

Pistol.

A New Automatic Pistol. Illustrated description of the Mars pistol and its operation. 1200 w. Engr, Lond—Dec. 6, 1901. No. 44924 A.

MINING AND METALLURGY

COAL AND COKE.

Brown Coal.

Brown Coal at Narracau (V.). Henry C. Jenkins. A report by the government metallurgist on this deposit. 1900 w. Aust Min Stand—Oct. 17, 1901. No. 44,-729 B.

British Coalfields.

British Coalfields; Their Extent, Duration and Condition of Working. The first of a series of twenty or more articles on the most prominent features and the most recent phases of this industry. 2000 w. Ir & Coal Trds Rev—Dec. 6, 1901. Serial. 1st part. No. 44917 A.

Coal Cutting.

The Use of Coal Cutting Machinery in the United States (Ueber die Verwendung von Schrämmaschinen bein Kohlbergbau der Vereinigten Staaten). H. Mellin. Describing the machines in general use and the extent to which they are used in America. 7500 w., 4 plates, Glückauf—Dec. 7, 1901. No. 45184 B.

Crushing Strength.

The Crushing Strength of Coal. Prof. R. C. Carpenter. Investigations of importance in connection with mining operations, where columns of coal are often left to support the roof of the mine. 1200 w. Sib Jour of Engng—Dec., 1901. No. 44,-994 C.

Great Britain.

Britain's Cheap Coal Supplies. The present article discusses the report of the Argyll Commission, and the light that has been thrown on this subject since that report was issued some thirty years ago. 3400 w. Ir & Coal Trds Rev—Nov. 22, 1901. Serial. 1st part. No. 44734 A.

Holland.

The Coal Basin of Limburg, Holland (Le Bassin Honillier du Limbourg Hollandais). A. Habets. A general description of these important bituminous coal measures, with maps and table of borings. 4500 w. 2 plates. Rev Univ des Mines—Nov., 1901. No. 45125 H.

Illinois.

The Divernon Coal Mine. J. J. Rutledge. An illustrated description of the plant and arrangements at mine No. 6, of the Madison Coal Co., at Divernon, Illinois. 4500 w. Mines & Min—Dec., 1901. No. 44,-779 C.

India.

Indian Coal. Concerning the recent progress made in the coal mining industry, the extent of the coal fields, etc. 1300 w. Engr, Lond—Nov. 29, 1901. 44860 A.

The Coal Question in India. Discusses the production, companies, labor question, mining methods, etc. 4800 w. Ind & East Engr—Nov., 1901. Serial. 1st part. No. 45034 B.

Japan.

The Coal Mines and Coal Trade of Japan. Gives a series of sectional maps showing the location of the principal collieries, giving a report of the mines, especially the Müke mines. 1200 w. Ir & Coal Trds Rev—Dec. 6, 1901. No. 44916 A.

Kansas.

Kansas Coal Mining. W. R. Crane. An illustrated article describing the deposits, methods of prospecting and mining, and other details. 5800 w. Eng & Min Jour—Dec. 7, 1901. No. 44828.

COPPER.

Cuba.

The Copper Mines of Santa Clara Province, Cuba. T. Weyland Vaughan. Describes the mines and the general geology, giving also an outline of the topographical features. Ill. 3700. Eng & Min Jour—Dec. 21, 1901. No. 45016.

Estimation.

Volumetric Estimation of Copper. Describes a method by which copper may be determined in its ores and metallurgic products in the shortest time and with the greatest accuracy possible. 1300 w. Aust Min Stand—Oct. 31, 1901. No. 44731 B.

Metallurgy.

The David Copper Process. Illustrates and describes a special converter called a "selector," explaining the principle and manner of operating and stating the advantages of the process. 3000 w. Engng—Nov. 22, 1901. No. 44739 A.

GOLD AND SILVER.

Assay Returns.

A Standard Assay Certificate Form. Submits a form suggested for assay returns, discussing the deficiencies of the forms usually employed. 1800 w. Min & Sci Pr—Dec. 14, 1901. No. 44971.

Austria-Hungary.

Gold Mining in the XIX Century, with Especial Reference to Austria-Hungary (Das Gold in XIX Jahrhundert mit besonderer Berücksichtigung der Oesterr.-Ungar. Monarchie). L. St. Rainier. With tables and diagrams showing the production of the various countries. 3500 w. Zeitschr d Oest Ing u Arch Ver—Nov. 15, 1901. No. 45165 B.

British Columbia.

Mining Operations in Atlin, B. C. R. Lind Watson. An illustrated description of some of the places and the hydraulic plants which are being installed. 2200 w. Mines & Min—Dec., 1901. Serial. 1st part. No. 44777 C.

The Dry Ores of the Slocan, B. C. R. C. Campbell-Johnston. Describes this area and the experiences of those mining its ores, the attempts to treat the ore on a paying basis, and gives suggestions for other treatments that may be applicable. 1800 w. Can Min Rev—Nov. 30, 1901. No. 44697 B.

Cyanide Mill.

A Cyanide Mill of the Black Hills, South

Dakota. Everett B. Sawyer. Describes the work done and gives the cost of milling. 1100 w. Min & Sci Pr—Dec. 7, 1901. No. 44873.

Cyanide Plant.

A Wet-Crushing Cyanide Plant at Ely, Nevada. Illustrated description of a mill nearing completion. It is one of the largest combination plants in the country for the treating of low grade gold ore by cyaniding after wet crushing and amalgamation. 2500 w. Eng & Min Jour—Dec. 7, 1901. No. 44829.

Goldfield.

Pitfield Plains Goldfield (V.). Stanley Hunter. A report of this field, describing the deposits, and the mines of the various companies working in this district. 2500 w. Aust Min Stand—Oct. 24, 1901. Serial. 1st part. No. 44730 B.

Idaho.

Some Idaho Mining Districts. Arthur Lakes. Illustrated description of the geological characteristics of the State, and of the mines of the Hailey gold belt and the De La Mar district. 5000 w. Mines & Min—Dec., 1901. No. 44780 C.

Making Gold.

Can Gold Be Made Artificially? Edward Booth. Discusses the claims made by the late Professor Wynne of Denver Col., that he had discovered the secret of making gold. 1400 w. Min & Sci Pr—Dec. 7, 1901. No. 44872.

Nevada.

The Mines of Tonapah Lake, Nevada. Describes a district recently discovered situated in a country very hard to prospect on account of lack of water. The ratio of gold and silver is about 39 per cent. gold and the rest silver. 1200 w. Eng & Min Jour—Dec. 14, 1901. No. 44951.

New Field.

A New Gold Field. W. K. Draper, in the *N. Y. Times*. An account of the deposits in the Wichita Mountains. Gold, copper and oil are found, but whether in paying quantities is not yet determined. 2000 w. Sci Am Sup—Nov. 30, 1901. No. 44654.

Sulphide Ores.

Broken Hill Sulphide Ores. J. C. Moulden. Describes the ores, their preparation for treatment, methods of treatment, web concentration of argentiferous sulphides, etc. 3500 w. Aust Min Stand —Oct. 31, 1901. Serial. 1st part. No. 44733 B.

Transvaal.

Mining Conditions in the Transvaal. A report of the present conditions. The industry slowly reviving under many difficulties. 2500 w. Eng & Min Jour—Dec. 21, 1901. No. 45017.

IRON AND STEEL.

Blast Furnaces.

Difficulties in Blast Furnace Operation (Ueber Störungen in Hochofengang). B. Osann. A study of the reactions occurring in blast furnace operation, with reference to the irregularities occurring in practical experience. 4000 w. Stahl u Eisen—Dec. 1, 1901. No. 45185 D.

Modern Iron Blast-Furnace Practice. F. H. Crockard. With special reference to the Methods and appliances which have developed as the result of the demand for intensified production. 3000 w. Engineering Magazine. Jan., 1902. No. 45052 B.

Feed Cone.

Electrically Operated Furnace Feed Cones (Elektrisch Betriebene Gichtglockenaufzüge). F. Janssen. Illustrating and describing applications of electric motors to the operation of the cone valves used on blast furnaces to admit the charge and retain the gases. 3000 w. Stahl u Eisen—Dec. 15, 1901. No. 45188 D.

Ferrosilicon.

The State of Silicon in Cast Iron and in Low Ferrosilicon (Sur l'Etat du Silicium dans les Fontes et les Ferro-silicums à Faible Teneur). P. Lebeau. A review of chemical researches showing the true combination existing between the silicon and the iron; confirming the results of metallographical investigations. 1200 w. Comptes Rendus—Dec. 9, 1901. No. 45,-139 D.

Fuel.

The Fuel Consumption in Iron Making (Ueber die Bremstoffverluste im Eisenhüttenbetrieb). A. Bergström. A discussion of possible sources of fuel economy in iron works, especially in connection with gaseous fuel. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 30, 1901. No. 45182 B.

Lake Superior.

The Hon. Peter White. A biographical sketch, including a history of the development of the Lake Superior iron region. 9200 w. Marine Rev—Dec. 12, 1901. Serial. 1st part. No. 44894.

Manganese.

On the Determination of Manganese in Spiegel. Thomas F. Hildreth. A comparison of new and modified methods for the estimation of manganese. 2000 w. Sch of Mines Qr—Nov., 1901. No. 44966 D.

The Manganese Deposits of Gandarella, Minas Geraes, Brazil. Joaquin G. Michaeli. Describes the deposits and their location. 1100 w. Eng & Min Jour—Dec. 21, 1901. No. 45018.

Mexico.

Mexican Iron and Coal. Information concerning the location and value of these deposits. Map. 1700 w. Col Guard—Dec. 6, 1901. No. 44919 A.

Open Hearth.

The Early History of Open Hearth Steel Manufacture in the United States. Samuel T. Wellman. Presidential address before the American Society of Mechanical Engineers. 6500 w. Ir Age—Dec. 5, 1901. No. 44754.

Ore Process.

A Variation in the Ore Process (Une Variation du Procée au Minerai). E. de Loisy. A description of the Goriainof open hearth steel process, used in the Ural district, Russia. 6000 w. Bull Soc d'Encour—Nov., 1901. No. 45130 G.

Ore Valuing.

The Valuation of Iron Ores (Ueber die Berwerthung von Eisenerzen). P. Lisl. Deriving a formula from which the value of an ore can be determined. The data are the price of pig iron, and the composition of the ore. 1200 w. Stahl u Eisen—Dec. 15, 1901. No. 45178 D.

Pig Iron.

On a Calometric Method for the Estimation of Sulphur in Pig Iron. W. G. Lindsay. Describes method and compares the results with the regular method. 800 w. Sch of Mines Qr—Nov., 1901. No. 44,965 D.

Rail Rolling.

Rail Rolling at Lower Temperatures During 1901. S. S. Martin. Information relating to rolling temperatures and the value of microscopic study. Ill. 1500 w. Ir Age—Dec. 26, 1901. No. 45002.

Rolling Mills.

The Neepsend Rolling Mills, Sheffield. Describes the improvements made and work done in this English mill. The products are wire, block sheets, sheets for saw blades, blanks for files, tool steel bars, etc. 2300 w. Engr, Lond—Nov. 29, 1901. No. 44857 A.

Steel Making.

Basic or Bertrand-Thiel Process (Thomas oder Bertrand-Thiel Process). O. Thiel. A comparison between the two processes, with tabulated analyses of products, showing that the open-hearth process is to be that of the future. 3000 w. Stahl u Eisen—Dec. 1, 1901. No. 45186 D.

Steel Works.

See Mechanical Engineering, Machine Works and Foundries.

MINING.

Accidents.

Berryburg Mine Disaster, W. Va. James W. Paul. A description of the mine, the conditions under which it was operated and the probable cause of the explosion. 3000 w. Mines & Min—Dec., 1901. No. 44778 C.

Mining Accidents in the Years 1896-1900 (Die Betriebsunfälle bein Bergbau in den Jahren, 1896-1900). J. Sauer. A tabulated account of the mining disasters in the Vienna district, including upper and lower Austria, Salzburg, Moravia, Silesia, and Bukowing. Serial. Part I. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 16, 1901. No. 45180 B.

Brazil.

Mineral Resources of the State of Minas Geraes, Brazil. Senator Costa Senna. An illustrated account of deposits of gold, diamonds, iron, manganese and other valuable minerals. 1400 w. Min & Met—Dec. 15, 1901. No. 44976.

Caving.

The Caving of Shaft No. 7 of the Bascoup Colliery (L'Eboulement du Puits No. 7, de la Société Charbonnière de Bascoup). A. Robert. Describing the manner in which the caving was checked and the shaft repaired. 3500 w. 1 plate. Rev Univ des Mines—Nov., 1901. No. 45127 H.

Explosions.

The Nature of Explosions. Review of the lecture of Prof. Dixon, at the Midland Institute, Birmingham, Eng. Gives the history of their use and the advances made, describing various explosions and their action. 3700 w. Col Guard—Dec. 13, 1901. No. 45043 A.

Idaho.

Idaho's Mining Industry. Arthur Stanley Riggs. Historical review and review of the mineral resources of this State. Gives a table showing 25 minerals mined in paying quantities and 23 minerals found but not mined. 3000 w. Min & Met—Dec. 15, 1901. No. 44977.

Mexico.

The Mining District of Pachuca, Mexico. Ezequiel Ordonez. Historical and descriptive account of this silver mining district. 3500 w. Eng & Min Jour—Nov. 30, 1901. No. 44763.

Mine Power.

See Electrical Engineering, Power Applications.

Mining Industry.

The Value of Science and Training in the Mining Industry. E. J. Babcock. Read before the International Min. Cong. at Boise, Idaho. On the importance of government recognition of the mining and metallurgic industries. 3000 w. Mines & Min—Dec., 1901. No. 44782 C.

Mining Law.

The Russian Law of Gold Mining. C. W. Purington and J. B. Landfield, Jr. A digest of the Russian law, explaining and commenting upon the text. 2500 w. Engineering. Magazine. Jan., 1902. No. 45048 B.

Quarry Methods.

Modern Quarry Methods. Extracts from a circular issued by the Ingersoll-Sergeant Drill Co., describing machine work. Ill. 1200 w. Stone—Oct., 1901. No. 44808 C.

Rescue Station.

The Colliery Rescue Station at Altofts. Illustrates and describes the arrangements for training men in the use of rescue appliances, and for testing their reliability. 2200 w. Col Guard—Nov. 29, 1901. No. 44856 A.

Shafts.

Clearing a Shaft of Water During Sinking. V. Kadainka, in *Oesterreichische Zeitschrift für Berg und Hüttenwesen.* Illustrated description of the method used. 1500 w. Col Guard—Dec. 6, 1901. No. 44918 A.

Tamping.

The Value of Tamping. A. W. Warwick. The writer favors the use of tamping and gives arguments supporting his conclusions. 1200 w. Min Rept—Dec. 5, 1901. No. 44841.

MISCELLANY.

Alaska.

A Trip to Dawson. Auguste Mathez. Describes the tour as easy and pleasant in the summer, all the difficulties and dangers of the past having disappeared. 2500 w. Mines & Min—Dec., 1901. No. 44,-781 C.

Alloys.

Alloys as Solutions. John Alexander Matthews. Historical review of metallurgy and the recent advances in alloys research, noting the general properties of metals, pointing out the similarities between ordinary solutions and alloys. 7200 w. Eng & Min Jour—Dec. 21, 1901. Serial. 1st part. No. 45019.

Aluminium.

Aluminium. Ernest Wilson. On the increase in the output, the progress in manufacture; showing how rapidly the electrolytic process has developed, alloys, as a conductor of electricity, uses, etc. Also discussion. 9000 w. Jour Soc of Arts—Dec. 13, 1901. No. 45023 A.

Asbestos.

Asbestos—Where It Is Found. Joseph Hyde Pratt. Describes the two distinct minerals called asbestos, and their varieties, the location of deposits, especially the deposit in Vermont. 2700 w. Am Mfr—Dec. 12, 1901. No. 44947.

British India.

Mineral Wealth of British India. A Summary of a statement issued by the director general of statistics. 1000 w. U. S. Con Rpts, No. 1210—Dec. 10, 1901. No. 44792 D.

Chili.

The Mining and Metallurgical Situation in Chili (Situation Minière et Métallurgique du Chili). Ch. Vattier. A review of the gold, silver, copper and other mining industries of Chili, Peru, Brazil, and other countries of South America. 8000 w. Mem Soc Ing Civ de France—Sept., 1901. No. 45118 G.

Corundum.

Montana Corundum. Leverett S. Ropes. Brief description of the deposits. 900 w. Eng & Min Jour—Dec. 14, 1901. No. 44,-950.

Germany.

Germany's Mining and Metallurgical Industries. H. L. Geissel. An illustrated review of these industries and their development. 2800 w. Min & Met—Dec., 1901. No. 44840.

Glass.

Machinery for Working Glass (Appareils Servant an Travail Mécanique des Glaces). E. Zoude. A mathematical discussion of the theory of machines for polishing and working glass. 10,000 w. 1 plate. Rev Univ des Mines—Nov., 1901. No. 45124 H.

Nickel.

The Sudbury Nickel Mines. A. McCharles. Some points in relation to prospecting with a favorable report of progress in nickel mining. 700 w. Eng & Min Jour—Dec. 7, 1901. No. 44830.

Petroleum.

Oil of the Northern Rocky Mountains. Bailey Willis. Considers the known occurrences in Canada and the United States, the geology and origin of the oil, and the prospecting. Map. 300 w. Eng & Min Jour—Dec. 14, 1901. No. 44949.

Rare Metals.

The Analysis, Detection, and Commercial Value of the Rare Metals. J. Ohly. Information for the purpose of facilitating researches, and indicating the more reliable methods of distinguishing and analyzing the minerals containing rare metals. 500 w. Min Rept—Dec. 5, 1901. Serial. 1st part. No. 44842.

Salt Works.

The Salt Works of Austria in 1898 and 1899 (Die Salinen Oesterreichs in den Jahren 1898 and 1899). Abstract of the official government reports. Serial. Part I. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 30, 1901. No. 45181 B.

Tasmania.

Tin Mining at St. Helens (T.). George A. Waller. Describes the deposits and the various workings. 4000 w. Aust Min Stand—Oct. 17, 24, 31, 1901. Serial. 3 parts. No. 44728 each B.

Zinc.

Aluminum-Zinc Alloys. Dr. Joseph W. Richards. Gives results of experiments made with these alloys and the proportions that give valuable results. 1000 w. Eng & Min Jour—Nov. 30, 1901. No. 44,762.

The Removal of Iron from Zinc Blende. Dr. William B. Phillips. Information concerning experiments made with a view of separating the iron-bearing compounds from the blende. 1800 w. Eng & Min Jour—Nov. 30, 1901. No. 44761.

RAILWAYS AND TRAMWAYS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in October. A condensed record of the principal accidents. 3500 w. R R Gaz—Nov. 29, 1901. No. 44670.

Train Accidents in the United States in November. Record of the principal accidents, with remarks on those of special interest. 4500 w. R R Gaz—Dec. 20, 1901. No. 44991.

Electricity vs. Steam.

The Electrification of Our Railways. Philip Dawson. Discusses this subject, especially the problem as related to suburban traffic. 2200. Elec Rev, Lond—Dec. 13, 1901. 45030 A.

Management.

Engineers and Railway Management (Eisenbahnbetrieb und Ingenieur). G. Gerstel. A review of the relation of the work of the engineer to the general details of railway operation and management. 7500 w. Zietschr d Oesterr Ing u Arch Ver—Nov. 29, 1901. No. 45170 B.

Siberian Railway.

From Pekin to St. Petersburg by Rail. Alfred Stead. An interesting account of a journey via Manchuria and Siberia to London; from Japan. 1800 w. Rev of Revs—Dec., 1901. No. 44703 C.

Trains.

Standard Trains. Discusses the increased weight of locomotives and rolling stock, and of axle loads, the composition of trains, etc. 2500 w. Engr, Lond—Nov. 22, 1901. No. 44742 A.

Train Staff.

The Train Staff on the Reading. Brief illustrated description of the electric train staff introduced in a short section of single track line between Mahanoy tunnel and Buck Mountain. 1000 w. R R Gaz—Dec. 6, 1901. No. 44803.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air Brake Maintenance. C. H. Quereau. Discusses the importance of having reports and a check inspection, suggesting a method. 1700 w. Ry & Engng Rev—Nov. 30, 1901. No. 44700.

I. Some Problems in Maintenance Arising from Rapid Increase in Air-Brake Equipment. E. M. Herr. II. What Shall Be Done to Maintain the Air-Brake Equipment on Our Freight Cars? T. W. Demarest. Two papers discussed together. 1300 w. W Ry Club—Nov., 1901. No. 44961 C.

Cars.

Large Railway Wagons. Illustrated description of fine cars built in England. 1700 w. Engng—Nov. 29, 1901. No. 44,852 A.

New 80,000 lbs. Capacity Box Cars for the Chicago, Burlington & Quincy Railroad. Drawings and description. 600 w. R R Gaz—Dec. 6, 1901. No. 44802.

The Increase in Capacity of Open Freight Wagons (Ueber die Erhöhung der Lade für Lingket der Offensen Güterwagen). H. von Schwabe. A discussion of the advantages of large coal cars, considering especially the Prussian railways. 5000 w. Glückauf—Nov. 30, 1901. No. 45183 B.

The Pennsylvania 100,000 Lbs. Capacity Box Cars. Illustrations from working drawings, with brief description. 700 w. Ry & Engng Rev—Dec. 7, 1901. No. 44,874.

Combustion.

Locomotive Combustion. J. W. Shepherd. Considers processes involved in locomotive combustion without entering into details of application. Also discussion 4300 w. W Ry Club—Nov., 1901. No. 44962 C.

Draft-Gear.

The Master Car Builders' Draft Gear Tests. A copy of the plan of draft rigging tests agreed upon. Ill. 1300 w. R R Gaz—Dec. 13, 1901. No. 44899.

The Sessions-Standard Friction Draft Gear—Type C. Illustrations with records of laboratory and drop tests. 2000 w. R R Gaz—Nov. 29, 1901. No. 44666.

Economy.

Economy in Locomotive Service. G. R. Henderson. Discusses economies regarding this service, and the various functions pertaining to it. The present article is devoted mainly to fuel and the practices affecting it. 3500 w. R R Gaz—Dec. 6, 1901. Serial. 1st part. No. 44799.

Economy in Plant for Traction Stations. Discusses methods of determining the most economical design. 1800 w. Elec Rev, Lond—Dec. 13, 1901. No. 45031 A.

Electric Locomotives.

Electric Locomotives and Motor Cars at the Exposition of 1900 (Les Locomotives et les Automotrices Electriques à l'Exposition de 1900). R. Godfernaux. Describing and illustrating some recent applications of electric traction to main-line service. 5000 w. Rev Gen des Chem de Fer—Nov., 1901. No. 45143 H.

Electric Locomotives for Shops. Illustrates and describes a storage battery electric locomotive, well adapted to the work for which it was designed. 900 w. R R Gaz—Dec. 20, 1901. No. 44990.

The Electric Locomotives of the Orleans Railway (Die Elektrischen Lokomotiven der Orléans-Bahn). H. Pforr. Full detailed description of the heavy electric locomotives, hauling trains from the Austerlitz to the Quai d'Orsay stations in Paris. 2500 w. 2 plates. Glasers Annalen—Nov. 15, 1901. No. 45171 D.

Electric Traction.

Tangential Traction. Translation of an article from the *Madrid Mining Review* on a system of electric traction. 1100 w. U S Cons Repts, No. 1214—Dec. 14, 1901. No. 44878 D.

The Wannsee-Berlin Electric Railway. Illustrates and describes a line that has been in operation since August, 1900, and that is equipped for heavy traffic. It is mainly used as a steam-locomotive line, running an electric train. 2800 w. Engr, Lond—Dec. 6, 1901. No. 44921 A.

Fuel Economy.

Methods of Reducing Fuel Consumption in Locomotives (Massanahmen zur Herabminderung des Kohlenverbrauchs im Lokomotivenbetrieb). H. Glasenapp. A description of the method of using the exhaust from the air-brake pump to heat the feed-water as practised in America. 1500 w. Tram & Ry Wld—Nov. 14, 1901. No. 45172 D.

Greenock.

The Tramways of Greenock, Port Glasgow, and Gourock. An illustrated article describing the line and its equipment. 3000 w. Tram & Ry Wld—Nov 14, 1901. No. 44750 B.

Interurban.

The Milan-Monza Interurban Tramway. Guido Semenza. Brief illustrated description of a road using the overhead system. 1200 w. St. Ry Jour—Dec. 7, 1901. No. 44833 D.

The New Bedford & Onset Street Railway. Illustrated description of a recently opened interurban line, with information concerning it. 2500 w. St. Ry Rev—Dec. 15, 1901. No. 45012 C.

Italy.

Electrical Tramways and Railways in Italy. Magrini Effren. Reviews the great development of electrically worked lines. 2200 w. Tram & Ry Wld—Nov. 14, 1901. No. 44751 B.

Locomotives.

Baldwin-Vanderbilt Ten-Wheel Passenger Locomotives—Atchison, Topeka & Santa Fe. Illustrates details of oil-burning 10-wheel passenger locomotives recently delivered. 600 w. R R Gaz—Nov. 29, 1901. No. 44669.

Brooks Chautauqua Type Passenger Locomotive, B., R. & P. Ry. Illustrated description of recently built engines using bituminous coal. 900 w. Ry & Engng Rev —Dec. 7, 1901. No. 44875.

Compound Freight Locomotive by the Vulcan Company (Locomotive Compound à Marchandises Construirte par la Société Vulcan). F. Barbier. Illustrated description of eight-wheel engine exhibited at Paris, 1900. 1200 w. I plate. Génie Civil —Nov. 23, 1901. No. 45100 D.

Compound Goods Locomotive of the Vulcan Company. Illustrations with detailed description of four-coupled goods engine for the Prussian State Railways. 800 w. Engng—Dec 6, 1901. 44929 A.

Consolidation Locomotive for the Mexican Central. Illustrated detailed description of large engine designed by F. W. Johnstone. 2200 w. Ry Age—Nov. 29, 1901. No. 44702.

Eight Wheels Coupled Coal Locomotive. Drawing and description of the latest type of mineral engine built for the North-Eastern Ry Co. of England, with an account of the work done by this class. 1200 w. Engr, Lond—Nov. 29, 1901. No. 44861 A.

Frames, Cylinders and Saddles—Pennsylvania Class E—2 Locomotives. Illustrates and describes changes made in the development of this class of engine. 800 w. R R Gaz—Dec. 13, 1901. No. 44900.

Locomotives at the Exposition of 1900 (Les Locomotives à l'Exposition de 1900). F. Barbier. Describing and illustrating the American and the French engines exhibited at Vincennes. 8000 w. 2 plates. Rev Gen de Chem de Fer—Dec., 1901. No. 45,-146 H.

Mogul Freight Locomotives for the Southern Pacific. Illustrations, dimensions, and brief description. 600 w. R R Gaz—Nov 29, 1901. No. 44667.

Prairie Type Passenger Locomotives. Illustrated description of one of the forty-five large engines being built for the A. T. & S. F. Ry for working passenger trains over the 16-degree curves and grades of

184-ft. per mile. 600 w. Am Engr & R R Jour—Dec., 1901. No. 44688 C.

Recent Locomotive Construction and Performance. F. J. Cole. An illustrated paper, with a lengthy discussion introduced by S. W. Vauclain. 20300 w. N Y R R Club—Nov. 21, 1901. No. 44963.

The Player-Baldwin Oil-Burning Consolidation Locomotives. General views and details of the design of Mr. John Player, with description and editorial. 2300 w. R R Gaz—Dec. 20, 1901. No. 44988.

Unsymmetrical Movement of Locomotives. Gives the contribution of Mr. Herdner to the discussion of Baron Joseph Engerth's report to the International Ry. Cong. concerning experimental investigations made. 2800 w. R R Gaz—Dec. 6, 1901. No. 44801.

Von Borries Four-Cylinder Compound Locomotive. From *Le Genie Civil.* An illustrated description of an example of the best practice in compound locomotive work abroad. 1200 w. Ry Age—Dec. 20, 1901. No. 45021.

Locomotive Tests.

Comparative Locomotive Tests. A record of locomotive tests on the Mich. Cent. Ry., undertaken to determine the policy of building heavier engines, and to ascertain the extent of their advantages, combined with wide fire-boxes and compounding. 2500 w. Am Engr & R R Jour—Dec., 1901. No. 44690 C.

Trials of the Compound Locomotives of the Western Railway of France (Essais Comparatifs avec les Machines Compound de la Compagnie de l'Ouest). E. Decourt. Full data and results of important trials of four-cylinder compound French and Italian locomotives. 10000 w. 5 plates. Rev Gen des Chem de Fer—Nov., 1901. No. 45142 H.

New England.

The System of the Milford, Holliston and Framingham Street Railway Company. An illustrated description of an interurban electric railway of interest. 2800 w. St Ry Jour—Dec. 7, 1901. No. 44831 D.

Oil Fuel.

Oil Fuel for Locomotives. H. B. Gregg. The present article gives an illustrated description of the essential equipment for the successful burning of crude oil in locomotives, and the operating of oil burners. 2500 w. Am Engr & R R Jour—Dec., 1901. Serial. 1st part. No. 44691 C.

Operation.

Notable Features in the Operation of the Union Traction Company of Indiana. An illustrated article describing interesting features of an extensive interurban line. 3200 w. St Ry Jour—Dec. 7, 1901. No. 44837 D.

Platforms.

Street Car Platforms. W. E. Partridge. An illustrated review of the various types and the mechanical appliances with which it is equipped. 2800 w. St Ry Jour—Dec. 7, 1901. No. 44836 D.

Resistance.

Train Resistance. J. A. F. Aspinall. Abstract of a paper read before the Inst. of Civ. Engrs. dealing with results of experiments carried out with a dynamometer car on the Lancashire and Yorkshire Railway, in an endeavor to arrive at the tractive effort required to haul modern railway carriages. Also editorial. 2000 w. Engr, Lond—Nov. 29, 1901. No. 44898 A.

Rolling Stock.

Tramway Rolling Stock at the Exposition of 1900 (Le Matériel Roulant des Tramways à l'Exposition de 1900). R. Godfernaux. A general review of the equipment for electric tramways as shown at Paris in 1900. 9000 w. 4 plates. Rev Gen de Chem de Fer—Dec., 1901. No. 45147 H.

Stray Currents.

Electrolysis of Underground Metallic Structures. L. C. Anderson. Explains the conditions accompanying gas or water-works piping systems and the methods of construction and operation of single trolley electric railroads, showing the effect and discussing the remedy. 4600 w. Fire & Water—Dec. 21, 1901. No. 45068.

Switzerland.

The Electric Tramway of St. Moritz, Switzerland. Brief illustrated description of an interesting installation. 700 w. Elec Rev, N. Y.—Dec. 14, 1901. No. 44,-956.

Trolleys.

A plea for the Bow Trolley. E. Kilburn Scott. Considers the advantages and disadvantages of collecting current by means of a bow contact and by means of a wheel. 800 w. Elec Engr, Lond—Nov. 22, 1901. No. 44720 A.

Control of Overhead Trolley Wire by Circuit Breakers in Feeder Boxes. Presenting the advantage of having the circuit breakers in the boxes. 500 w. Elec Engr, Lond—Nov. 22, 1901. No. 44722 A.

Underground.

Shallow Underground Tramways. C. H. Wordingham. Reviews the report of Messrs. Baker and Rider, presented to the London County Council. 2600 w. Elec Rev, Lond—Dec. 13, 1901. No. 45032 A.

Water-Scoops.

Experiments with Track Tank Scoops. Gives results of some experiments made last year on the N. Y. C. & H. R. R. 900 w. Am Engr & R R Jour—Dec., 1901. No. 44692 C.

Theory of Locomotive Water-Scoops. I. P. Church. Explanation of case with open trough, and case with closed pipe. 1400 w. Am Engr & R R Jour—Dec., 1901. No. 44689 C.

Wigan.

Wigan System Corporation Electric Tramways. Illustrated detailed description of the present system which will probably be extended. 2700 w. Tram & Ry Wld.—Nov. 14, 1901. No. 44749 B.

NEW PROJECTS.

Bagdad Railway.

The Bagdad Railway Project. Information relating to the line under construction by German capitalists, and the proposed branches. Ill. and map. 1200 w. Rev of Revs—Dec., 1901. No. 44704 C.

Extension.

The Islington Extension of the City and South London Railway. A description of this recently opened section, and its equipment. Ill. 1700 w. Transport—Nov. 22, 1901. No. 44708 A.

The Pennsylvania and Long Island R. R. Extensions Across the North and East Rivers. Gives a map showing the projected tunnels and bridges across the North and East Rivers, and discusses the work. 1700 w. Eng News—Dec. 19, 1901. No. 44984.

High-Speed.

High-Speed Electrical Traction in Germany. A description of the apparatus built for the high-speed traction experiments on the Berlin-Zossen military railway, with critical remarks concerning its adaptation to the use for which it is intended. 4200 w. Elec Rev, N. Y.—Nov. 30, 1901. No. 44672.

The Proposed New York and Portchester Railway. Particulars of the plans and extracts from the testimony given to prove the convenience and necessity of the road. 10500 w. St Ry Jour—Dec. 7, 1901. No. 44838 D.

London Underground.

New Underground Electric Railroads for London. Discusses proposed plans for relieving the congested traffic of the streets. 1700 w. Sci Am—Nov. 30, 1901. No. 44650.

The Electrification of the London Underground Railway (Die Elektrisirung der Londoner Untergrundbahn). An editorial discussing the relative merits of the continuous and polyphase systems of electric traction for the London Underground Railway. 2500 w. Elektrotech Zeitschr—Nov. 28, 1901. No. 45195 B.

Mountain Railways.

Difficult Mountain Railway Construction in Switzerland. Contour maps and description of new lines under construction, especially the line connecting Thusis with St. Moritz, involving a number of compound loops, mostly in tunnel, with numerous tunnels, bridges, etc. 1700 w. Eng News—Dec. 19, 1901. No. 44987.

Russia.

Railroads in Russia. Interesting information of the roads furnishing direct connection between St. Petersburg and Port Arthur. 1300 w. U S Cons Repts, No. 1213—Dec. 3, 1901. No. 44863 D.

Switzerland.

New Railway Projects in Switzerland (Neue Schweizerische Eisenbahn projekte). Robert Moses. Discussing matters of costs and concessions for new railways in Switzerland. 2000 w. Schweizerische Bauzeitung—Dec. 7, 1901. No. 45177 B.

The Montreux—Bemese Oberland Railway (Die Montreux—Bemer Oberland-Bahn). An account of the new electric road to run between Montreux to Lake Thun, through the Bemese Oberland. 3000 w. Maps. Schweizerische Bauzeitung—Nov. 23, 1901. No. 45176 B.

PERMANENT WAY AND FIXTURES.

Car-Transfer.

Standard Car-Transfer Bridge; N. Y. Central & Hudson River R. R. Illustrated description. 900 w. Eng News—Dec. 19, 1901. No. 44982.

Bonding.

Rail Bonding. W. A. Neff. On the importance of proper rail bonding, calling attention to some points often neglected. 1200 w. Tram & Ry Wld—Nov. 14, 1901. No. 44752 B.

Grade Crossings.

A Grade Crossing Removed at Harrisburg, Pa. An illustrated description of the work of eliminating the Market street grade crossing. 500 w. Ry Age—Dec. 6, 1901. No. 44827.

The Abolition of Grade Crossings on the Providence Division of the New York, New Haven & Hartford Railroad, Between Boston and Dedham. Arthur S. Tuttle. A statement of the conditions and requirements of the decree of the court, with illustrated description of the construction. 9400 w. Jour Assn of Engng Soc's—Nov., 1901. No. 45074 C.

Rail Joint.

An Improved Rail Joint (Nouveau Joint pour Rails). An illustrated description of the Scheinig and Hofmann system, extensively used in Austria-Hungary. 1000 w. Revue Technique—Nov. 10, 1901. No. 45111 D.

Railway Curves.

The Field Practice of Relining Railway

Curves. Howard C. Ives. Considers the cases under three heads, giving methods used by writer. 1500 w. Eng News—Dec. 26, 1901. No. 45056.

Repair Shops.

Extensive Repair Shops at Kansas City. Illustrated description of the repair shops of the Metropolitan St. Ry Co. of Kansas City now in progress of construction. 1200 w. St Ry Jour—Dec. 7, 1901. No. 44834 D.

Round House.

The Round House of the Pittsburg & Lake Erie R. R. Brief illustrated description of the structure at McKee's Rocks, Penn. 700 w. Ry Mas Mech—Dec., 1901. No. 44764.

Station.

Concrete Passenger Station for the Northern Pacific Ry., at Bismarck, N. D. Illustrated description. 1200 w. Ry & Engng Rev—Dec. 21, 1901. No. 45006.

New Station for the Southern at Knoxville, Tenn. Brief illustrated description of a fine station now in process of construction. 500 w. Ry Age—Dec. 6, 1901. No. 44826.

Terminal.

Port Richmond Terminal of Philadelphia and Reading Ry. Illustrates and describes what is supposed to be the largest seaboard railroad terminus in the United States, if not in the world. Covers 140 acres of ground and contains 73 miles of track. 1500 w. Ry & Engng Rev—Dec. 14, 1901. No. 44942.

The Long Island Railroad Entrance to Manhattan. Illustrates the proposed terminal at Thirty-third St., near Broadway, giving information concerning the plans. 500 w. R R Gaz—Dec. 6, 1901. No. 44800.

Track Construction.

Street Railway Track Construction at Scranton, Pa. Illustrated description of a substantial system comprising a concrete base, T rails, steel ties and reinforced joints, with brick and asphalt paving. 2000 w. Eng News—Dec. 26, 1901. No. 45060.

The Track Construction Department of the Union Traction Company, Philadelphia. Illustrated description of track apparatus and tools used by this company. 2500 w. St Ry Jour—Dec. 7, 1901. No. 44832 D.

Tunnels.

See Civil Engineering, Construction.

Yards.

Yards for Sorting Freight Terminal Classification. Presents plans of division and terminal yards, discussing the requirements. 2200 w. R R Gaz—Dec. 20, 1901. No. 44989.

TRAFFIC.

Freight.

The Decline in Freight Car Performance. Reviews the efforts being made by J. W. Midgley to get the roads to agree upon a per diem charge for the use and detention of cars. 3300 w. Ry Age—Dec. 13, 1901. No. 44944.

London.

Electric Railway Communication Within the Metropolis. Editorial discussion of the schemes and the modifications introduced. 3000 w. Engng—Nov. 29, 1901. No. 44854 A.

Passenger Service.

Special Local Passenger Service on a Steam Railway to Compete with an Interurban Electric Road. Illustrates a special car built for the Dayton & Union R. R. describing its equipment. 500 w. Eng News—Dec. 5, 1901. No. 44796.

Rates.

Preferential Rates. A letter from Walker D. Hines, objecting to statements recently published in this paper. Also editorial. 2300 w. Ry Age—Dec. 20, 1901. No. 45020.

Tonnage.

The Train Tonnage Craze. G. W. Turner. Unfavorable to heavy tonnage trains. Discusses the subject. 1600 w. Ry & Engng Rev—Dec. 14, 1901. No. 44943.

MISCELLANY.

Accumulators.

Accumulators and Electric Traction Systems. Discusses the use of storage batteries especially as related to present conditions in England. 2200 w. Elec Rev, Lond—Dec. 13, 1901. No. 45033 A.

Interurban.

The Relation of Interurban Roads to City Roads. Ira A. McCormack. Read before the American St. Ry. Assn. Discusses traffic agreements, rails, cars, and various matters, giving the agreements of various cities in the United States. 6600 w. St Ry Jour—Oct. 12, 1901. No. 43729 D.

Operation.

The Public, the Operator, and the Company. C. S. Sergeant. Read before the American St. Ry. Assn. Considers some points in the relations of street railways to the public. 2800 w. St Ry Jour—Oct. 12, 1901. No. 43727 D.

Russia.

Russia's Oldest Main Railroad. An account of the Nicolas line, which has just passed its fiftieth anniversary. 1300 w. Engr, Lond—Dec. 6, 1901. No. 44922 A.

EXPLANATORY NOTE.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.

Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
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Ingenieur. *w.* Hague.
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THE MISCHIEVOUS FALLACY OF OVER-PRODUCTION.

By George H. Hull.

It is not often that an industrial journal enjoys the privilege of presenting an economic discussion which is so apt, so able, so convincing, and so essentially practical, as the paper which Mr. Hull has here written. We commend it unreservedly to the thoughtful study of every reader of THE ENGINEERING MAGAZINE; and with the hope of adding something to the effective value of his sound teaching, we also invite attention to the Editorial Comment which appears elsewhere.—THE EDITORS.

MANY articles have recently appeared in the press discussing the threatened diversion of British manufacturing trade to other countries. No one of these has hit the nail so squarely upon the head, as that of Benjamin Taylor, of Glasgow, entitled "How Trade Unionism Affects British Industries." Mr. Taylor makes it clear that the all-pervading blight to British industry is the development of trade unions upon the controlling principle of "restriction of production," and that this has grown out of the widespread belief in the false theory of over-production.

He cites the fact that in America and Germany a workman may simultaneously "tend" several machines; that he often tends two, three, or even six; whereas in Britain, if a union worker dare attempt to tend more than one machine, he is brought before his district committee, reprimanded, and heavily fined. Many instances are cited where the union workman is limited in the amount of individual product to one-half, one-third, and one-fourth what a non-union worker will easily produce in the same time. One case is cited where a union worker was allowed to turn out but one-sixth, and another but one-twelfth what a non-union worker easily produced. Certain trades are mentioned in which the restriction of production increased until the trades were driven entirely out of Britain into Germany and Belgium. Mr. Taylor recognizes that at the present time, "the great object in American production is the saving of labour," while "the great object in British trade-union production is the dissipation of labour."

As Prof. Jevons has pertinently said: "It is certain that if people do not understand a true political economy, they will make a false one of their own." Already the most potent factor in influencing workers to "nurse their jobs," limit their production and join in strikes, is their growing belief that over-production is the cause of industrial depressions; that if all the producers are fully and continuously employed, it will sooner or later result in over-production; that over-production would deprive many of them of work, whereas the curtailment of production, brought about by union regulations and strikes, prevents or postpones such results.

It is not alone in the minds of the mechanics and workmen that this pernicious belief in over-production is obtaining lodgment. It has already deluded thousands of manufacturers and merchants, and evidences of it frequently crop out in the commercial reviews of our ablest newspapers. The harm this mischievous term has done in Britain, and is commencing to do in America, is sufficient reason for the exposure of so obvious a fallacy. For the fact is that political economy is nothing more than a collection of every-day, common-sense, business truths; and the sooner industrial managers are aroused to an appreciation of this fact, the sooner we shall have stability, security and industrial peace.

The process of collecting natural products is called farming, or mining, or fishing. The process of chemical or mechanical change which fits them to satisfy the various wants of man is called manufacturing. The act of transporting them and placing them within the reach of the consumer is called commerce. Each act or process which adds to the utility and exchangeable value of matter is "production of wealth." Value is added to the tree in the forest by the effort expended in felling it. More value is added by sawing it into lumber; more value is added by transporting the lumber to a market; more value is added by fashioning the lumber into forms and shapes to satisfy the various wants of man. A mahogany log in a West India forest is relatively of small value; delivered in London or New York it is relatively of large value. The acts of chopping it down and transporting it to a market are just as much production of wealth as the voluntary process of nature in producing the tree.

Just as production is a creation of utility and value, so consumption is a destruction of utility and value. Food is consumed by eating it; coal is consumed by burning it; lumber, stone, brick, and iron are consumed by using them in the manufacture or construction of things desired by man. Houses, ships, machines, clothing, and utensils, are consumed by wearing them out. In short, all creation of value, utility, and wealth, comes from production; all destruction of value, utility, and wealth results from consumption. The theory of over-production is founded upon the belief that by the introduction of machinery, improved methods, etc., it is possible for man to produce more than man is able to buy, or more than man desires to acquire. Let us analyze these propositions.

John Stuart Mill says: "What a country wants to make it richer is never consumption, but production. Where there is the latter, we may be sure that there is no want of the former." Professor Jevons also says: "People (British workmen for example) lose sight of the fact that we do not work for the sake of working, but for the sake of what we produce by working." Workmen everywhere are apt to think their comforts would be doubled if their pay was doubled. To analyze this, let us suppose that at a given time the pay of all persons engaged in any gainful occupation is doubled, while production remains the same. Is it not clear that the cost of everything would be doubled, and that each one with his double pay would be able to buy only as much as he did before? On the other hand, suppose that the pay remains the same to each, and that at a given time, by improved machinery, the productive force of each worker is doubled. Is it not plain that the cost of everything would be reduced one half, and that each one, on the same pay, would be able to buy twice as much as before? Obviously, then, the only practical way to double the reward to workers is to double their products; for as Professor Jevons strikingly observes: "It is absurd to suppose that people can become richer by having less riches. To become richer we must make more riches, and the object of every workman should be, not to make work, but to make goods as rapidly and abundantly as possible."

All great authorities agree that general over-production is an impossibility, though many admit that over-production in one or more articles frequently occurs. I take issue with all who make this admission. I claim that these exceptions are not cases of "over-production," but simply cases of *temporary surplus production*—and that temporary surplus production is not only natural but that it is necessary to man's comfort and welfare.

Man long ago discovered that the earth yields its food products during short annual periods which we now call harvest; and that if he would enjoy these products continuously, he must gather and store up of the surplus during these periods, sufficient to satisfy his wants until the next harvest. This was man's first lesson: that temporary surplus production was a necessity to his comfort and welfare, and was not "over-production." Over-production is a term which should never be applied to the production of any useful or desirable commodity, which can be preserved or carried to a place or time when it will be needed.

Only a few years ago there were seasons when the receipts of fruit in all large cities were sometimes so great within a few days, and thereby prices were forced so low, that the fruit scarcely brought the amount of the freight. Very often large quantities went to decay for lack of demand. This in turn discouraged shipments, and then would succeed a season of great scarcity. It took experience and many years of loss to rectify this condition, but finally it was accomplished by the establishment of fruit exchanges and cold-storage warehouses, where fruits can be preserved in a perfect condition for months. The result is that prices of all such products are now more stable, the public is more regularly supplied, at all seasons, consumption has been enormously increased, and the profits of both producers and dealers are more uniform and remunerative. It was *temporary surplus production* of fruit, before it was brought under intelligent control, which caused irregularity in the supply.

In our ignorance we called it over-production.

It was not over-production.

It was *temporary surplus production.*

Despite all our efforts to prevent it, unerring nature persisted in thrusting before our notice as the one and only thing out of which it was possible to create regularity—a harvest season, a temporary oversupply. So we find vegetables, eggs, butter, fish, poultry, and many other perishable articles, getting the benefit of an intelligent system which brings regularity of supply out of irregularity of production. As man masters the art of dealing intelligently with the temporary surplus production of each article, we hear no more of over-production in connection with that article.

And what is true of perishable farm products, is true in even greater degree of all staple articles of manufacture. A few generations ago every nail produced was hammered out by hand. Now, by the aid of machinery, one man will turn out a thousand times as many nails as in the days of our grandfathers. During the interim, the temporary inequalities between supply and demand have many times required to be adjusted to each other. We have had, in other words, frequent temporary surplus production of nails, but in the end the nails have been consumed. None have been destroyed for want of a market, and hence we have had no over-production of nails. The fact that such inequalities have always occurred and will continue to occur, simply emphasizes the importance of making some wiser provision than at present to turn them to profit when they do occur.

In Ecuador they mine gold by hydraulic power and must do it in daylight. But the streams are full of water at night and practically dry all day. So long as people lamented the nocturnal "over-production" of water, they produced no wealth. When they built dams to store the water at night, they provided means to mine by day. This is a striking example of the way we must turn to profit all cases of temporary surplus production of staple commodities. It is during periods of large production that we can most economically gather reserve stocks of such products as we know are sure to be in demand during periods of recurring prosperity.

Thus we see that man, though slowly, is learning to understand the wisdom of nature in giving him her products in temporary excess of current consumption, and that what man has long regarded as the disturber of regularity, and called over-production, was nature persistently thrusting upon his attention the only condition out of which he could possibly accumulate wealth and create regularity. If temporary surplus production of perishable products like fruit and vegetables is the only condition available for increasing consumption and creating stability in the supply and prices of these things, is it not reasonable to believe that temporary surplus production of imperishable articles, like iron and copper, is the only condition available for creating stability in the supply and prices of these staples? To waste the labor and the facilities to produce such commodities to full capacity in dull times, when it is certain they will be in great demand in active times, as Talleyrand says, "Is worse than a crime; it is a blunder."

The fact that most people believe that the accumulation of unsold goods is caused by "over-production," or that twin absurdity, "under-consumption," is not to be wondered at. On its face the theory seems to be self evident, just as it seems to be self evident that the sun rises and sets. But there is no more truth in one than in the other. This plausibility is what makes these terms so deceptive and mischievous, and probably no other popular error has done so much harm in the industrial nations of the world.

Each period marked by the accumulation of unsold goods in all industrial countries for a century past, has been a period of small production. History shows no instances in which a period of large production has been marked by the accumulation of unsold goods. Let us illustrate this by a period so recent that the truth must be plain to every one.

On October 1, 1898, the United States were producing iron at the rate of 10,800,000 tons per annum and had on hand a stock of 630,000 tons. The rate of production increased rapidly and by December 1, 1899, they were producing at the rate of 15,700,000 tons per annum and had but 124,000 tons of stock on hand. Why did not the stock increase during this period? Simply because the enormous production of wealth in the form of buildings, machinery, transportation facilities, etc., more than absorbed all the iron which could be produced.

From December, 1899, to December, 1900, the production of iron decreased to a rate of 11,200,000 tons; the stock increased from 124,000 tons to 720,000 tons, and immediately the cry of over-production was raised all over the country. What an absurdity, to cry over-production of iron when the country was actually producing less iron by 4,500,000 tons per annum than it was one year before, when there was no accumulation. The accumulation did not occur when the production was greatest. It occurred when production had been greatly reduced. It was the under-production of constructive enterprises which caused the accumulation of iron in 1900, as it did also the accumulation of all other constructive materials. Iron had risen in market value a clean 165 per cent. Coal, copper, tin, lead, rubber, lumber—indeed all the great staples followed the lead of iron, as is always the case; and with what result? People simply stopped buying. They saw plainly that prices were too high, and that they were certain to come down. Building plans were abandoned or laid aside, railway betterments were postponed, and manufacturers throughout all lines of industry limited purchases to actual daily needs. The natural and inevitable result followed: the price of iron and steel declined sharply —in Europe as well as America—all other prices followed, and immediately there was a resumption of constructive enterprise. More than this, every well-informed man now sees plainly that it was the fall in prices from an abnormal level which revived industry, stimulated enterprise, increased the demand for iron, and so stimulated production that the American output rose to the highest figures ever reached; and there are at present no signs of an accumulation of stocks.

By creating the modern systems of transporation, and by inaugueating the present system of cold storage, two long strides have been taken. Neither of these advances would have been possible but for the existence of one of nature's greatest gifts to man, *temporary surplus production.* Yet another long stride forward will be taken when the producers of staple commodities like coal, iron, steel, tin, copper, lead, and rubber, clearly understand that the present systems of storing these products are wholly inadequate. In the case of perishable agricultural produce, Nature long ago made it necessary for the merchants and bankers who handle them to adopt scientific systems of negotiable warehouse receipts for their safe storage. But in the case of the less-perishable staples of manufacture, we are still hobbling along with the antiquated methods of our grandfathers—every producer for himself, and the devil take the hindmost! The result is shown in the violent fluctuations of market values which we have lately seen in coal, iron, steel, copper, and rubber—extreme fluctuations which are wholly needless, and which are certain to be rendered impossible so soon as producers, merchants, bankers, and brokers can be brought to see the demoralization and waste that spring from mere lack of system in storing and carrying temporary surplus supplies of materials which form the very basis of all industry and all wealth.

Is there anything in nature or history which does not teach man that if he would have anything when needed, he must gather it when it can best be produced? Is it not good business to gather surplus products when they are plenty and cheap and hold them until they are scarce and high? Have any ten years passed in the recollection of men now living, in which the people of the foremost manufacturing nations have not suffered for the want of an adequate supply of some of the great staples—coal, iron, steel, tin, copper, rubber—which might have been stored up in times of dull trade? Has any one ever heard of useful manufactured products being destroyed for want of a market? Have they not all been consumed in time? Is not this proof that each one of the over-production claims put forth during the last two and a half centuries has been rank nonsense? Has not modern society simply failed to grasp one of Nature's great truths?

Finally, is it possible for man to produce more than man desires to acquire? Let us consult the economists on this point. W. Stanley Jevons says: "There can never be, among civilized nations, so much wealth that people would cease to wish for any more. However much we manage to produce, there are still many other things which we want to acquire." John Stuart Mill says: "A little reflection must inevitably lead us to see that no person, no community, ever had, or probably ever will have, all its wants satisfied." David Ricardo says: "Whilst a man has any wished-for gratification unsupplied, he will have a demand for more commodities; and it will be an effectual demand while he has any new value to offer in exchange for them." Francis A. Walker says: "It is under-production which makes hard times. Over-production, general over-production, is impossible, and, were it to occur, were the creation of wealth to outrun men's capacity to consume, no one would be injured thereby. But under-production is an unmistakeable evil. It means less wealth produced, and consequently fewer of the comforts and necessaries of life, on the average, to each member of the community."

Thus we see that the only natural limit to a people's power to acquire, possess, and enjoy material wealth, is their capacity to produce wealth—that products in themselves are *buying power.* We see also that products are wealth; that wealth increases *in the proportion that production exceeds consumption;* that it is impossible for wealth to increase so rapidly, or so largely, that it would exceed man's desire to possess it, or his power to pay for it. It follows therefore that there cannot be too much production of any useful article that can be safely stored. In short, large production does not cause hard times, but on the contrary it creates industrial prosperity.

We see also that when production is cut down in any particular line of business, it cuts down the buying power of those engaged in that line of business. Immediately we see the piling-up and accumulation of the class of goods ordinarily consumed by those engaged in that branch of industry. The accumulation of unsold goods is not an evidence of too much production, but on the contrary of too little production by those workers who ordinarily consume that kind of goods.

The difference between the poorest nation on the globe and the richest is simply a difference resulting from the difference of production. Every day of idleness, every hour of loafing, or striking, or "nursing a job" is a permanent and irreparable loss to the producer, the employer, and the community. It is a sacrifice of something the worker might have possessed, and can no more be replaced than the lost day can be replaced. No obstacle should be allowed to stand in the way of man's capacity to produce to the utmost; nothing should be allowed to stand in the way of man's increasing his comforts, luxuries and wealth, except the natural limit to his energies.

There is no limit to human desire. Every man who owns a factory, a house, or a yacht, would like to own a larger or a better one. The man who controls a bank, would like to control a number of banks and a number of trust companies. Having gained these, he would like to control great railroad systems, steamship lines, coal mines and manufactories. Having gained these in one country, he would like to control them in all countries.

Man's desires increase with his successes. Whatever one man achieves in wealth and power, others will desire to achieve, and will strive for. The average wealth of the individual in the United States has increased a thousand per cent. in less than a century, yet no man is so gorged with possessions that he desires no more. If in time the poorest live in the luxury in which the richest now live, there would still be a desire for more wealth. There are hundreds of millions in other lands who have not even commenced to produce wealth. Not one human being in twenty on this globe has to-day what might be called the reasonable comforts of life. The luxury and comfort of to-day was not conceived of a century ago, nor can the human mind to-day conceive of what will be regarded as the obtainable luxuries and comforts a hundred years hence. The desire to possess wealth and power is a natural instinct, implanted in man's breast by his Creator. It is this instinct which brings civilization out of barbarism. It is this instinct which moves the civilized world.

Whenever scarcity in the supply of any important commodity forces the price of that commodity up to the point of restricting its use—thus bringing on industrial depression—it is simply nature reminding us that there has been too little temporary surplus production of that article in the past.

Both nature and art give their products to man in a disproportionate manner, not to be wasted, but to be intelligently cared for; and if he does not so care for them, he is certain to suffer for his neglect.

Since the dawn of civilization the importance of storing up stocks of such things as were necessary to the life, defense and well being of man, has been recognized by all nations and people. The Scriptures, from Genesis to Revelation, abound in accounts of the immense store houses and store cities builded and maintained by the great nations of ancient times. They not only gathered in the months of harvest sufficient to supply the people until the next harvest, but they stored up in years of plenty sufficient to provide for years of famine. This wise provision ranked first in importance in all temporal affairs.

Is this one of the lost arts?

Verily what Thomas Arnold wrote years ago is still true: "What is called ancient history, is the most truly modern, the most truly living, and the most rich in practical lessons for every succeeding age."

MONEY-MAKING MANAGEMENT FOR WORKSHOP AND FACTORY.

By Charles U. Carpenter.

II.—A CONCRETE EXAMPLE OF SUCCESSFUL ADMINISTRATION.

In his initial article of this series, in our preceding number, Mr. Carpenter developed a rational and economical system of organisation for controlling the detail operations of the factory. To prove its efficacy in actual work, in spite of its seemingly radical character, he now takes a concrete instance which by its long-assured and pronounced success proves the working efficiency of the scheme proposed. The next article will take up the details of receiving, keeping, and issuing stock and of the processes of machining.—THE EDITORS.

IN considering the best methods of gaining an increase of work from the workmen in the factory, sanitation must always receive a large share of attention. In order to secure the very best results from men, their bodies must be in good physical condition, and their minds must be alert. Good light results in better and quicker work with a minimum of effort. Good air results in a more healthful condition of the body, a greater capacity for prolonged and concentrated effort, and an alert, wakeful mind. As a reply to the plea of expense for advanced methods of supplying and heating pure fresh air, may be quoted the answer of a manufacturer to an objector: "Yes, it does cost money for fuel to heat such a quantity of pure air, but my men don't become drowsy early in the afternoon; just as much work is being produced at 5:15 p. m. as at 7:15 a. m." The extra cost is a very small fraction of the final results. Fresh air, good light, and first-class sanitary facilities do pay a fine return on the investment necessary to secure them.

Suggestions and Complaints:—Many firms are neglecting what has proven, in many cases, to be a veritable mine of valuable information when they fail to adopt some means of inducing their workmen to make suggestions in the line of improvements. The workman comes in close contact with the minute details of the work, and his constant association with these details impels him to think of many improvements and economies that would never occur to the foreman or supervisor. A long experience has demonstrated that most valuable suggestions will be received from the men if they know that they will receive full credit for their ideas and have an opportunity to win a monetary prize. To insure this a note should be sent to each person making a suggestion, no matter how trivial, thanking him cordially and assuring him that it will meet with serious consideration. The workmen will feel the slightest hint at a rebuff in a matter of this kind. The money prizes which should be offered need not be so large in amount as large in number. Certificates, which are invariably highly prized, should also be given to each prize-winner.

To insure success it is necessary that these suggestions reach the highest authority in the factory, directly. A number of firms have adopted autographic registers and placed them in different parts of their plant: the workman writes his suggestion on the paper which is exposed at the top of the machine, turns the crank, tears off and keeps his copy. A duplicate carbon copy is retained in the machine under lock and key and these duplicates are gathered by a messenger and delivered to the secretary of the board of supervisors, or to those who are highest in authority.

The most surprising results will follow an effort to interest the men, especially if the foremen join with the firm in persuading and advising their men to make these suggestions. This can be accomplished by giving the foremen to understand that the number of suggestions received from a department, after taking into consideration the nature of the work, is part of the basis on which the firm forms its opinion of their efficiency. The direct benefit to the firm in money value will inevitably be followed by a greater efficiency in the working force. The result will be a decided increase in the interest of the men in their labor, and a greater concentration of their minds on their work, which will naturally bring the best results. Each man is spurred on by the knowledge that his ideas will be presented to the highest officials without the intervention of any one, and that, if he shows by his suggestions any degree of ability, he will be a man marked for advancement. Again, the firm is thus able to pick out from the ranks of the workmen the men of ability with whom to strengthen the organization when the need appears. This in itself is a very decided benefit.

Such a system arouses the best qualities of every individual in the entire body of workers; each one feels that opportunity is within his reach, and that reward is certain if he but prove worthy. Its basic principles properly developed, must result in wise decisions, effective orders, freedom from costly errors, large economies, development of the best men, and a remarkable degree of personal interest on the part of all in the business of the firm.

Practical illustration of Working of System:—In order to illustrate better the effectiveness of these ideas, it will be well to cite a concrete case and describe the details of the system herein advocated as developed in a factory where it has been in practice for over six years, bringing results that are remarkable. I refer now to the National Cash Register Company, of Dayton, Ohio.

This factory is selected, first, because here the system is worked out to the fullest extent possible; as a result it is famed all over the world for its admirable management. Second, because in this factory the work is so varied in its character, the amount of stock handled is so large, and the need for accuracy is such, that the system may be considered as working under the most difficult conditions possible.

This development is due to the wonderfully progressive spirit and indomitable will of the president of the company, Mr. John H. Patterson. By him these methods have been carried into not only the factory management, but also the executive and sales branches as well, with what success the business world is quite familiar. His great genius for organization has had full sway here and the results have more than justified the statement already made that the system of organization as herein outlined is an unqualified success.

Character of Product:—In this factory there are manufactured 206 different styles of machines. A large number of the orders received are special. There are assembled and shipped each day an average of 160 registers, which represent the labor of 2,700 workers. In each of these machines there are from 1,200 to 3,000 parts. In all there are over 13,000 different kinds of stock carried. In the assembling rooms are handled an average of 300,000 pieces of stock each working day. In the inspection room, through which all stock must pass in its manufacture, there were handled in one year over two hundred million (200,000,000) pieces of stock, many parts requiring a number of operations. There are over 22,000 piece-work prices representing about 75 per cent. of the total number of operations on this stock. The machines are very intricate and the mechanism is of the finest. To add to the difficulties of the case, the machine rooms are of comparatively limited capacity. There are in all forty-five separate factory departments, including machine rooms of all kinds, assembling departments, blacksmith shop, large wood-working department, large brass foundry, polishing and plating rooms, an elaborate printing department, bindery, etching and photograph departments. These represent work of the most varied character.

Old Systems:—This company, operating under the old plan of management, discovered that the systems were totally inadequate to meet the conditions that had arisen owing to the natural increase in the business. The system of management was inefficient, and the factory systems, including costs, stock, piece-work, inspection, stock-tracing, tool-making, and machining proved unreliable, cumbersome and very costly.

New Plan of Organization:—Finally a plan of organization, on the lines advocated in these articles, was determined upon. The board of supervisors* was formed, composed of five experienced men. The men composing this board were mechanical experts, inventors and experts in factory management and systems. They were chosen not only because of their ability in some particular lines, but also because of their sound judgment and ability in handling large affairs. At the meetings of this board the fullest and freest discussions prevail, with the result that all phases of any subject are fully brought out. Each man brings to these meetings his own ideas and his own wide experience, and each member avails himself of the privilege of taking up these ideas and discussing them with the other members of the board. The result is that the conclusions and orders of this board, having as a basis the experience of these five members, cannot but show the effect of the general discussions and the consideration that is given to any important question and, consequently, are remarkably effective. The efficiency of each member is naturally increased greatly owing to this free interchange of ideas.

Sub-Committees:—In addition to this board there were appointed a number of "machine committees" to take care of the complaints, suggestions, and improvements pertaining to the particular machine for which they were appointed. These committees are composed of the entire board of supervisors and foremen of the assembling, tool, tool-supply, stock and cost, and inspection departments. The work of these committees is of the greatest importance; all suggested improvements, inventions, and new designs, being carefully considered from the standpoint of every man on the committee, and any and all difficulties of any nature whatever being fully and freely discussed and methods adopted to correct them.

Very frequently other foremen are called into these meetings for consultation. The members of the committees and the foremen called upon soon become trained into the company's methods and they are very naturally developed into much stronger and more valuable men to the company. The result is that the heads of factory departments come into closest contact, in many ways, with the details of the factory work. Every man is alive to make improvements and better the conditions of his department, for he knows his own efficiency is judged by that of the department of which he is the head. Each feels that he is, in fact, an active and important part of an organization in which no shirking can or will be tolerated, and at the same time one in which due credit will be given for a highly efficient department.

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* See THE ENGINEERING MAGAZINE, February, 1901, page 699.

The comparison of the admirable results obtained by this method with those that might reasonably be expected under the ordinary system of management, will very strikingly demonstrate the advantages of this system and the great defects of the one in common practice.

Foremen's Meeting:—Every two weeks there is called a "foremen's meeting" in which all heads of departments meet with the entire board of supervisors, and at times the general manager. At these meetings care is taken to draw out the foremen, and they are given to understand that a free and full expression of opinion on any proposition is always valued, especially if it is in the nature of a criticism that may lead to some reform. Each man is given the fullest possible opportunity to ask for anything that may be needed to better his department and to complain of anything that is hindering him from reaching the desired point of efficiency. This general meeting is of great value in ascertaining the true cause of any difficulty that may exist. Both the management and the men are benefited by this free interchange of ideas and expression of opinion.

Company Club House:—The company has also provided a club house in which the noon-day meal is served to the officers of the company and all heads of both office and factory departments, all sitting at one table. Here are taken up many of the points of the business, a discussion of which might prove beneficial to both the men and the company. Hardly a week passes without the presence of some prominent guests, often from far-distant lands. The discussions that arise as to the methods prevailing in the different sections of the world are very instructive, and tend to broaden the horizon of the men as could nothing else. This bringing together of these men develops a feeling of fellowship and mutual interest between them and the management, the results of which are far-reaching. It is a great aid in bringing about that desire for co-operation with one another for the good of the company which has wrought such wonders in this particular case.

The heads of departments thus come into close contact with the officials of the company, and in case any one of them has made a marked improvement that will benefit the organization, his work is recognized in a manner that impresses all with the idea that the officers of the company thoroughly appreciate any worthy and successful effort to benefit a department and the organization. The inevitable result of this is that all are moved with one desire and aim, viz., to concentrate all their energies to improve their departments, to build up the company, and to strengthen the organization and increase its efficiency at every point.

General Committees:—In addition to these meetings of committees and boards, there is a building committee, an inventions committee, and also a joint meeting of the office and factory. The names of these committees are an indication of the nature of their duties, which are naturally of vast importance. In addition to these, there are a number of others formed in the executive, recording, and sales branches of the business.

Suggestions and Complaints:—In the matter of receiving and considering suggestions from the workmen, this company is probably in advance of any other concern in the world; as a consequence, their experience is the best possible foundation upon which to base a statement of facts. To those who have made no attempt to develop properly the possibilities in this line of improvement, the results will be astonishing. No doubt some tact and skill must be used in introducing such ideas, but when properly done and with proper encouragement, the savings and improvements will more than repay the firm making the experiment, many times over. And again, as mentioned before, the increased interest and attention of the men to their work is most beneficial to the entire organization.

Sanitation:—This firm has demonstrated that it does pay from a financial standpoint to give close heed to the question of sanitation. Their experience has shown beyond the possibility of doubt that good light, fresh air, and good closet facilities have a direct bearing upon the product of the workmen. So decided was the gain that their new shops were designed and built so as to give all the light possible, and ventilating systems instituted which permit of frequent changes of air kept at a very even temperature.

Resumé:—The experience of this company, building a machine that is extremely complicated and of many parts, necessitating great accuracy, as well as rapid and economical handling of an immense quantity of stock, has proven the great efficiency of its system. Its fundamental principles and final results can be stated in few words.

Discussions by committees:—Resulting in wise decisions, great economies, and efficient management.

Quick decisions:—Leading to rapid action.

Individual responsibility:—Tending to relieve officials of useless burdens.

Suggestions:—Resulting in important improvements and increased interest.

Complaints:—Forcing correction of serious faults.

Promotion:—Providing inspiration to individual effort.

General Meetings:—Resulting in a redoubling of interest and bringing forward of strong men.

Such an organization can not be otherwise than progressive, because of its encouragement of complaints and suggestions; flexible in its ability to meet any situation, however sudden; efficient and strong in its development of strong men, in its great reserve power, and because it rests upon the combined wisdom, intelligence, and ability of all its strongest members.

THE GROWTH OF ECONOMY IN MARINE ENGINEERING.

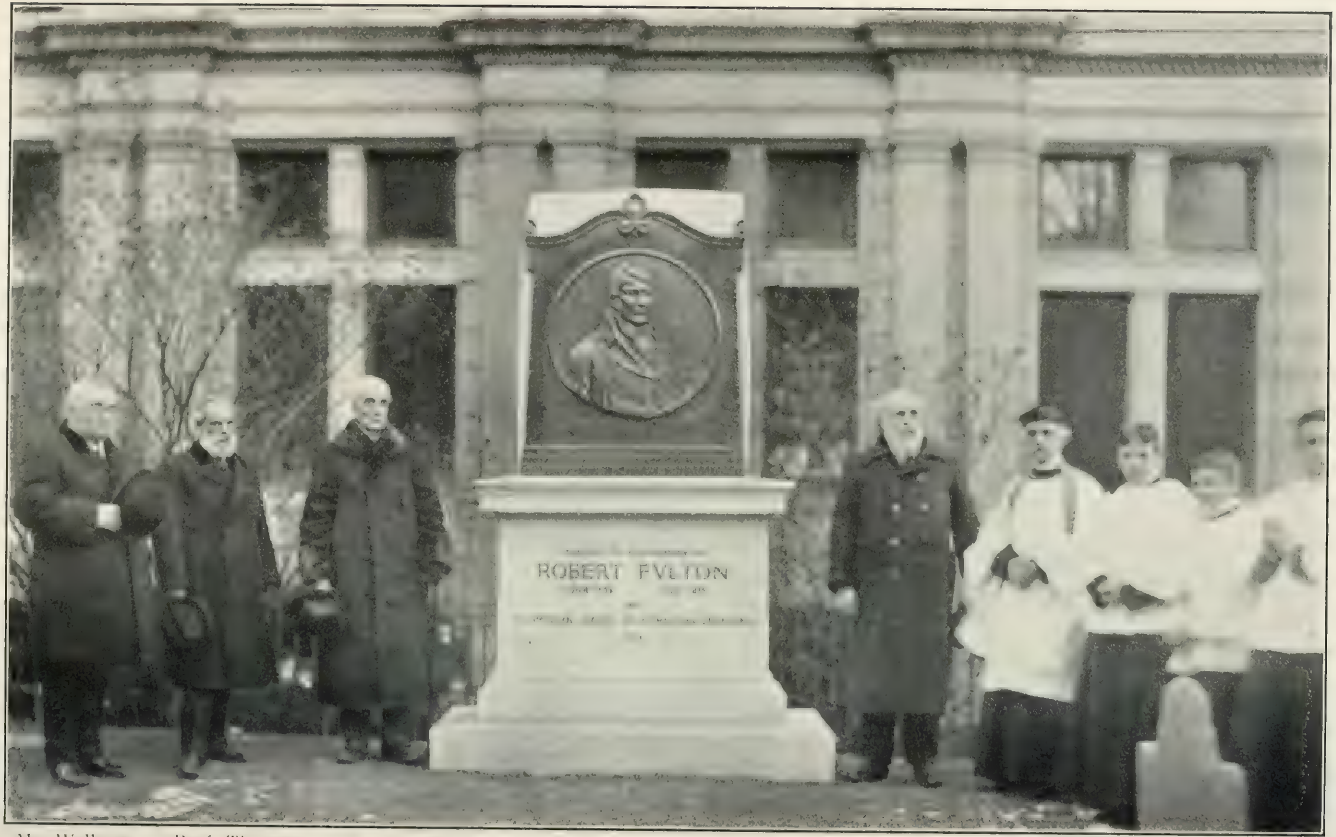
By Walter M. McFarland.

There is no more remarkable example of the commercial value of applied science in engineering than the development exhibited in the domain of marine engineering. In the series of papers of which this is the first, Mr. McFarland traces that growth from the invention of the steamboat down to the present time, showing how the fuel consumption has been reduced to one-tenth of that required in 1825. Mr. McFarland's long and intimate connection with the Bureau of Steam Engineering of the United States Navy renders him especially well fitted to narrate the story of this marvellous development.—The Editors.

THE PERIOD OF THE SIMPLE ENGINE.

THE century which has just closed has witnessed enormous strides in every branch of engineering, and in none has the progress been greater than in marine engineering. At the beginning of the century, indeed, it may be said to have had no existence, while at the end it has reached such a state of development that further progress seems very difficult and the exact line along which it is to take place uncertain. To attempt a general review of marine engineering progress with any degree of detail would require a much greater space than could be afforded by this magazine, and in these articles consideration must be limited to the question of economy, treating this mainly with reference to the cost of power as measured in coal and steam per horse power, but also considering some features of design which have been productive of economy, although not directly in the reduction of the cost of power.

I shall not attempt to go back to the very beginning of steam propulsion in the latter part of the eighteenth century, for no data whatever are available of the cost of power at that time—and indeed the same may be said of the early years of the nineteenth century. It will not be amiss, however, to remind the reader that the beginning of commercially successful steam navigation was with the American steamer Clermont, designed and built under the supervision of Robert Fulton in New York, which made its first trip from New York to Albany in August of 1807. The engine of the Clermont was built by Boulton & Watt of England, and the boiler and hull at the ship-yard of Charles Brown on the East River. In the Clermont, as in most of the early steamers, pine wood was the fuel, and although there are some records of the cords of wood used for a trip, no attempt appears



Mr. Wellman. Prof. Thurston. Mr. Haswell. Admiral Melville. Rev. Mr. Crary.

DEDICATION OF THE MONUMENT TO ROBERT FULTON, TRINITY CHURCHYARD, NEW YORK.

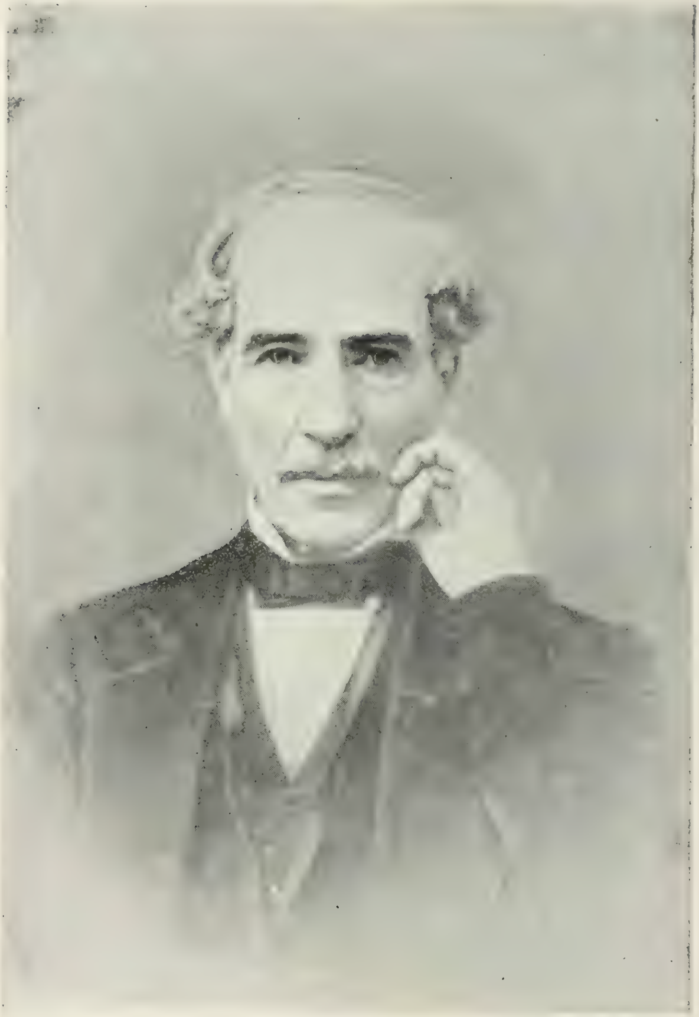
This photograph is interesting in that it contains the first Engineer-in-Chief of the U. S. Navy, Mr. C. H. Haswell, in his 94th year, as well as the present Engineer-in-Chief, Rear Admiral Geo. W. Melville, U. S. N. The others present are Mr. S. T. Wellman, President A. S. M. E.; Professor R. H. Thurston, and Rev. Robert Fulton Crary, grandson of Robert Fulton.

to have been made to determine the cost per unit of power. According to Doctor Thurston, anthracite coal was first used for fuel on the steam boat Passaic in 1818 under the direction of Mr. Robert L. Stevens, who was also the inventor at a later date of the familiar "Stevens cut-off," which is still used on so many beam-engine steamers.

These early steamers carried a very low steam pressure and used the steam without expansion. Moreover, as the paddle wheel was the propelling instrument, the rotational speed was very low, and as a result, in the light of our present knowledge, we should anticipate that the cost of power would have been very high. It is impossible to give absolutely accurate figures, inasmuch as no attempt appears to have been made to determine carefully either the horse power or the fuel expenditure. Some of the early writers on marine engineering mention the coal expenditure as ten pounds per indicated horse power, and, under the circumstances, this does not appear at all extravagant. We have some records of the first steam war vessel of the United States Navy—the Fulton—built in 1837, whose first chief engineer was Mr. Charles H. Haswell, the nestor of American engineering, who is still alive at the advanced age of ninety-four. An extract from the Fulton's steam log for a portion of January, 1838, shows that the maximum steam pressure was 11 pounds, the vacuum 24 inches, and the maximum revolutions per minute 18.

The early marine engines are a good exemplification of the law of evolution, for they were adaptations of the form of engine which had proved successful on land, with the consequence that they were of the type known as the "beam engine," and its modification, the "side-lever engine." The former has continued in use for light-draft American river steamers even up to the present day, and the side-lever engine was the favorite for sea-going steamers almost up to the close of the paddle-wheel period. What was known as the "inclined engine" was used in many cases for war vessels where it was desired to keep the machinery below the water line, and the old paddle-wheel steamer Michigan, which is still in service on the Great Lakes, was designed in 1843 with engines of this type.

As is well known, the benefit to be derived from using steam expansively was discovered at an early day and is included by Watt in his patent of 1769. It was, therefore, very natural that as soon as marine engines had shown their reliability progressive designers should endeavor to get the benefit due to expansion. As stated above, the Stevens cut-off was invented in 1841, and the Sickles cut-off was also invented about the same time and was applied to the engines of the



CHARLES H. HASWELL,

First Engineer-in-Chief in the U. S. Navy. Born 1809; Chief Engineer, 1836; Engineer-in-Chief from 1844 to 1850.

Michigan. That there was a reduction in coal expenditure was, of course, shown by the coal used per day or per trip, although there is still no record of the coal used per unit of power. Up to 1850 steam pressures were still very moderate, although many students of economy realized that the cost of power would be reduced if the steam pressure were raised so as to allow for greater expansion. The curious feature to an engineer educated at the present time is that, although the steam-engine indicator was invented by Watt, and thus had been available for many years, it seems to have been very little used. The horse power of the engines was usually calculated from the boiler pressure and the dimensions of the engine, sometimes with an allowance for a fall of pressure, but there are no records of any tests having been made with the indicator. In a book written in 1850 by a British naval officer who was evidently anxious for improvement, we read such a statement as the following:

> "An indicator should be fitted to every cylinder and should be constantly fixed there in order that the effective pressure of the steam may be known by inspection at all times. It is usual in most cases merely to apply the indicator when the engine is about to leave the maker's hands, and, the power being calculated, it is removed. By making constant observations of the reading of the indicator we should at once perceive how much the evaporative power of the boiler decreases from incrustations or other causes, also the comparative effects of different kinds of fuel and modes of treating the furnaces. In short, the whole economy of the engine may be determined by it."

The author speaks of indicator diagrams, but, strange as it may seem, not a single diagram is given in the whole book. Under such circumstances it is not surprising that the economy remained low.

It is interesting to note that in all the discussions of the benefit to be derived from expansion it never seems to have occurred to the engineers of that time that there was any limitation. The expansion of steam was treated as if steam were a perfect gas, and the law of Mariotte, "that, with constant temperature, the product of pressure and volume is constant," applied without any limitations. It was, of course, realized that there was a practical limit to expansion, from the consideration that too great a ratio would cause a mean forward pressure so low that when the back pressure came to be deducted the mean effective pressure would be so small as to require a very large engine with its accompanying great friction. The effects of liquefaction were unknown, and, indeed, it does not seem to have been suspected that there was such a thing as liquefaction. The truth with respect to expansion and liquefaction was experimentally demonstrated and promulgated—if, indeed, it was not discovered—by that famous American engineer, Chief Engineer Benjamin F. Isherwood, who was the engineer-in-chief of the American navy during the civil war.

The first definite data of the cost of power which I have been able to discover, after considerable research, appear in a book by Chief Engineer Isherwood published in 1858, entitled "Engineering Prece-

CHIEF ENGINEER B. F. ISHERWOOD, U. S. N.

Engineer-in-Chief of the U. S. Navy, 1861-1869. Designer of the most successful marine engines of his time, contributing by his researches upon the action of steam in the cylinder, to the modern knowledge of cylinder condensation.

dents." Even at that early date Mr. Isherwood gave evidence of his genius and pains-taking analysis of engineering data. This book contains a number of indicator diagrams, some of which show very creditable steam distribution. It contains information in considerable detail with respect to the machinery of some English vessels built about 1855 and of about 840 horse power. The steam pressure was 9 pounds per square inch above the atmosphere and the coal consumption per day was 40 tons, which gives the coal per horse-power hour about 4½ pounds.

Mr. Isherwood became engineer-in-chief of the American navy in 1861, but before that time he had conducted the experiments which first made him famous, and the report of which has remained an engineering classic to this day. These were the experiments on the U. S. S. Michigan for the purpose of determining the limitations to expansion and the amount of liquefaction. The experiments were made by a board of naval engineers, of which Mr. Isherwood was president, and were conducted in January, 1861. The engine used was one of a pair 36 inches in diameter and 8 feet stroke. The boiler was of the Martin vertical water-tube type, having 45 square feet of grate surface and 1,385 square feet of heating surface. It may be remarked that this was the second set of boilers on the Michigan, and had been installed in 1859. These were still in use on the Michigan when I served on that vessel in 1882-3, and they were then in excellent condition. They were finally removed and replaced by a third set in 1892, thus having lasted thirty-three years, a record probably unique in marine engineering. The accompanying table shows the results of these experiments, and from them we note at once the utter fallacy of the opinion almost universally held up to that time that the greater the degree of expansion the greater the degree of economy. As will be observed, the greatest economy occurred when the steam was cut off at four-ninths of the stroke, which, with the allowance for clearance, meant about two expansions. The table contains a line which shows the percentage of steam not accounted for by the indicator, or, in other words, the dif-

EXPERIMENTS ON EXPANSION, U. S. S. "MICHIGAN."

	Point of Cut Off.					
	7/10	4/9	3/10	1/4	1/6	4/45
Ratio of expansion, including clearance	1.4	2.12	2.95	3.42	4.60	7.15
Steam pressure above atmosphere......	19.5	21.0	21.0	21.0	21.0	22.0
Revolutions per minute..............	15.56	17.28	13.69	13.87	11.17	14.1
Mean effective pressure in pounds per square inch	27.6	24.1	19.9	17.4	13.6	8.8
Pounds of feed water (100° F.) per horse power per hour, tank.....	34.8	33.08	35.2	34.47	37.04	46.08
Per cent. of feed liquefied to equal work	8.74	9.04	8.59	8.77	8.45	7.94
Per cent. of feed not accounted for by indicator	6.60	18.14	33.07	30.84	33.66	37.16
Diameter of cylinders to give same power and speed, inches...... ...	36.0	39.5	42.7	45.4	51.3	63.5

U. S. S. MICHIGAN.

Launched at Erie, Pa., in 1843, and still in active service, with the original engines. It was on this vessel that Mr. Isherwood conducted his famous researches.

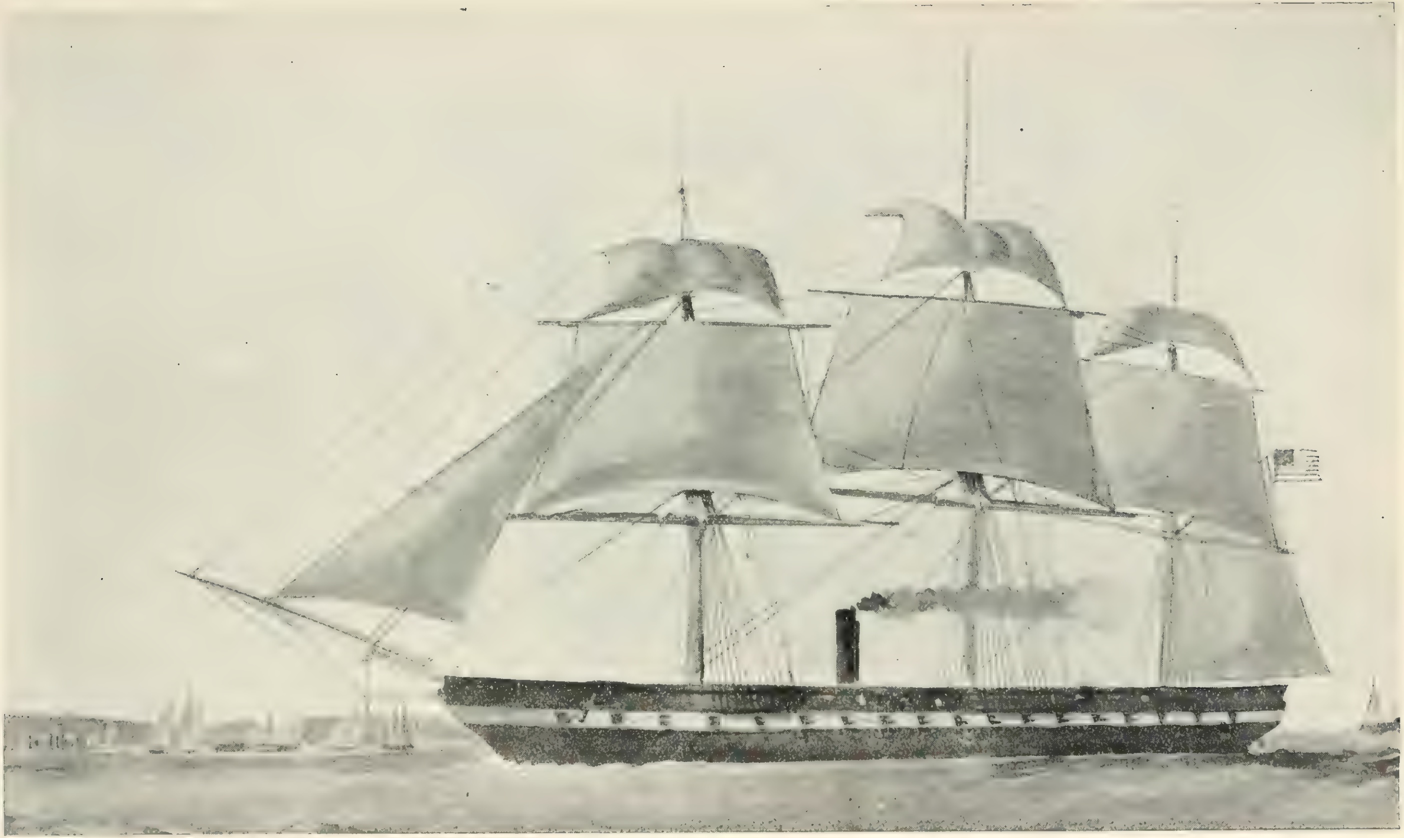
ference between the water actually fed into the boilers and the quantity of steam which should have been required had there been no liquefaction other than that due to the expansion of the steam itself. It will be noted that for the highest grade of expansion this unaccounted for percentage amounts to as much as 37 per cent. of the total amount accounted for by the tank measurement, or, in other words, nearly 70 per cent. of the amount accounted for by the indicator.

It would seem that the result of these experiments should have been to convince engineers of the futility of using high degrees of expansion with low-pressure steam and slow-moving engines, but this was not the case; and indeed the lesson was not thoroughly learned by some designers even as late as the eighties of the last century. During the American civil war there was an extremely heated controversy of great interest to all engineers, due to the attacks of a patent lawyer in New York named Dickerson, who was an amateur designer, upon Mr. Isherwood. Dickerson accused Mr. Isherwood of professional ignorance and of waste of government money in designing engines that worked with very low expansion. Dickerson had sufficient influence to be allowed to design the machinery for the U. S. S. Pensacola to embody his ideas with respect to expansion, and the machinery was a complete failure and had to be removed from the vessel. In spite of this he was again successful in getting permission to design another set of machinery, which was installed in the U. S. S. Algonquin. This vessel was similar in every respect, except machinery, to the U. S. S. Winooski, which was fitted with machinery designed by Chief Engineer Isherwood. The vessels were not completed until after the close of the civil war, when a series of competitive trials was conducted under the auspices of a board of marine engineers not connected with the navy, this arrangement being to prevent any complaint by Dickerson that his machinery had been tested by people friendly to Isherwood and hostile to him. The trials included runs at the dock and also in free route, and in both cases the Winooski with Isherwood's machinery was entirely successful, while Dickerson's on the Algonquin was a failure. The board concluded its report as follows: "In every point guaranteed by the contractor for the Algonquin machinery (Dickerson) he has failed, and we are of the opinion that it is totally unfit for the naval service."

In 1863 there appeared the first volume of Mr. Isherwood's work entitled "Experimental Researches." These included the record of the performance of a number of naval vessels on trial and in regular service, and also the detailed data of various experimental trials of marine machinery made under Mr. Isherwood's direction, and in many cases under his personal supervision. In all cases they were accompanied by an analysis and discussion of the results by Mr. Isherwood himself. In this first volume are the records of the performance of a class of naval screw steamers built from 1854 to 1856, which were then the largest vessels in the American navy, one of them being the famous Merrimac. These vessels were of about 4,600 tons displacement, 300 feet long, 50 feet beam, and 21 feet draft. The engines were of about 1,300 horse power, working with a steam pressure of 13½ pounds above the atmosphere and making about 45 revolutions per minute. A record of the maximum performance in smooth water showed a coal consumption of 4.37 pounds of coal per horse-power hour. Under ordinary steaming conditions at sea, when a certain amount of heat was lost, due to "blowing off" to reduce the density of the water in the boilers (the condensers were of the jet variety), and using anthracite coal with 18 per cent. refuse, the coal consumption was six pounds per horse-power hour.

It is a little difficult in such an article as this to be strictly chronological without a break in the continuity. I have, therefore, not mentioned the change from paddle wheels to the screw as a means of propulsion. The screw propeller was actually used successfully on a small steamer as early as 1804; indeed this little boat of 68 feet length, built by Colonel John Stevens, used twin screws. The actual introduction of the screw propeller for large vessels was about 1836, by Ericsson and Smith. It seems probable that one of the main reasons which delayed the earlier introduction of the propeller was the comparatively inferior workmanship of that period, which made it difficult to construct engines which would run at the relatively high speed necessary for driving the propeller. As we now know, the very fact of increasing the rate of rotation caused an increase in economy by the reduction in the amount of condensation in the cylinders. Paddle-wheel steamers continued to be built even after the successful introduction of the screw propeller, and during the civil war in America some paddle-wheel steamers were built, but these were for special service where light draft was very necessary.

During this war the depredations of the confederate privateers—notably the Alabama—were so disastrous to American shipping that the Navy Department decided to build a class of vessels which would be faster than any others afloat, either in the naval or merchant service. The most famous of these vessels was the Wampanoag, whose machinery was throughout the design of Chief Engineer Isherwood, who also



U. S. S. MERRIMAC.

One of the finest warships of her day. Launched at Boston, Mass., 1855. Captured by the Confederates at Norfolk Navy Yard in 1861, and converted into the ironclad which was defeated by Ericsson's Monitor.

designed the lines of her hull. She was not completed until after the conclusion of the war, but in February, 1868, she was given a full power trial at sea from Sandy Hook to near Cape Hatteras. The performance was the most wonderful record for a steamer in the history of marine engineering up to that time, and in many respects it remains the most remarkable that has ever occurred. As the books which contain the record of this trial are now rather difficult of access, a brief statement of the performance is here given, because the record is one that should be known to all engineers.

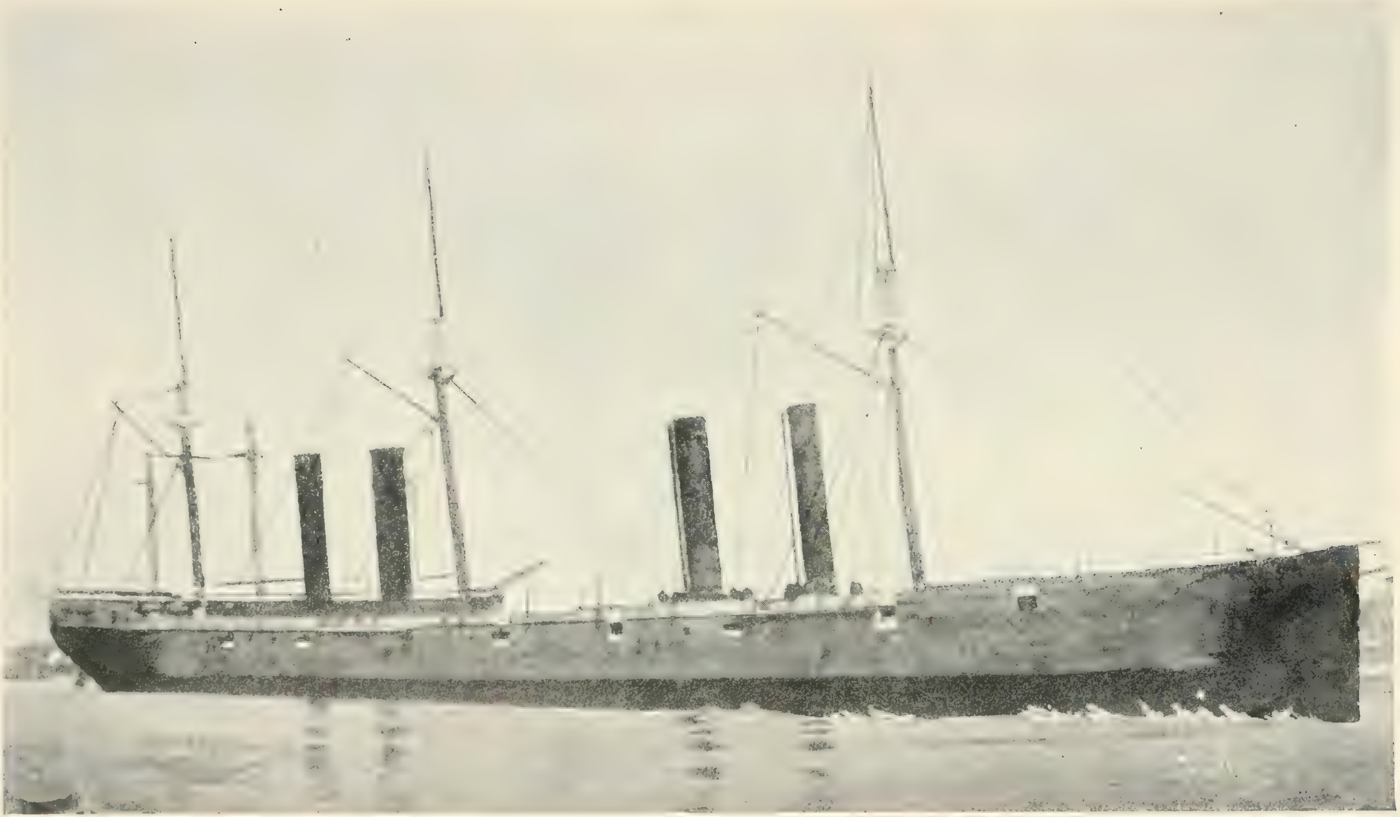
FULL-POWER TRIAL OF U. S. S. WAMPANOAG, AT SEA, FEBY. 11 AND 12, 1868.

Duration of trial, hours	37.5
Average speed, knots	16.7
Highest average speed for six hours	17.0
Maximum speed, one hour	17.75
Revolutions of engines per minute	31.06
do. do. screw " "	63.67
Steam pressure in boilers, pounds	32.0
Vacuum, inches	26.0
Coal per hour, pounds	12,690
do. do. do. per indicated horse power, pounds	3.15
Indicated horse power	4,049

The speed of the Wampanoag was greater by at least four knots than that of any other vessel then afloat, and it is to be noted, too, that this was not a fair-weather performance lasting only four hours with picked coal and high-priced firemen. The trial lasted for thirty-seven hours and was conducted in the winter off the Atlantic coast. The weather was indeed so stormy that the trial was ended by the coming on of a heavy gale. As seen by the table, the steam pressure carried was 32 pounds above the atmosphere and the coal consumption was 3.15 pounds per horse-power hour. We should doubtless not be far wrong in assuming that this cost of power represents about the best economy in simple engines working under good average conditions at sea.

During the whole of his term as engineer-in-chief, Mr. Isherwood took advantage of every opportunity to make careful tests of all the new classes of machinery built for naval vessels, and also of superheated steam, ratios of heating to grate surface in boilers, and, in general, whatever would conduce to progress and increased efficiency and economy.

Among these experiments were competitive tests of the horizontal fire-tube and the vertical water-tube boilers, which showed a slightly superior economy of evaporation for the latter, so that it became the common type in the navy. This boiler must not be confounded with the modern water-tube boilers, for it was a shell boiler. It had



U. S. S. WAMPANOAG.

The fastest vessel of her day, having made a speed of 17.75 knots on her trial trip, February, 1868. The photograph represents the cruiser as she lay at New London, Conn., shortly before she was broken up.

none of the advantages of the later type, but did have all the disadvantages. One of these, the inability to plug a leaky tube without laying off the boiler, was largely conducive to its final abandonment. The experiments on ratios of heating to grate surface also gave valuable and much needed data to designs, which were the standards until forced draft changed the conditions.

It is also interesting to note that on a class of small gun-boats (nineteen in number), known as the "Chippewa class," forced draft was installed and regularly used. He took advantage of this opportunity to test the relative economy of evaporation with natural and with forced draft, and found that when the rate of combustion was increased from about 8½ pounds of anthracite with natural draft to about 20 pounds per square foot of grate with forced draft, the evaporation per pound of combustible was reduced about 30 per cent.

It has been mentioned above that the engines designed by Mr. Isherwood during the civil war did not use a high degree of expansion. As a rule they cut off at about seven-tenths of the stroke, which as all engineers know, would give an excellent card from the engines, both as regards expansion and compression. It is to be remembered that the steam pressures used at this time were very low, and the Michigan experiments had demonstrated that, while for their particular conditions a cut-off at four-ninths was the most economical, the table given shows that a cut-off at seven-tenths differed very little in economy. It is to be remembered that in naval machinery there is a feature which is of just as great importance as economy, if not greater, namely, weight. The advocates of extreme expansion seem never to have considered this point, but it was one which Mr. Isherwood realized thoroughly and which he frequently discusses in the "Experimental Researches." It has frequently been remarked despite what has just been said that Isherwood's engines were extremely heavy, and this is true considered from a purely academic standpoint. The great engineer, however, is not the man who designs machinery simply in accordance with the rules in text books, but the one who comprehends all the conditions which he has to meet and meets them successfully. This Isherwood did in a marked degree. Many years ago I had the pleasure of hearing Mr. Isherwood discuss this very point, and his reasons are conclusive. It was much more necessary that the engines should never break down than that they should be of the lightest weight consistent with ordinary design. The immense expansion of the American navy during the civil war necessitated utilizing the services

U. S. S. POWHATAN.

The most reliable and fastest ship of the old navy of the United States. This ship formed one of Commodore Perry's squadron which opened Japan to the commerce of the world.

of a vast number of engineers who, while men of natural ability, were in many cases without previous experience. To have put machinery designed for lightness in their hands would have resulted in many cases in break-downs. Something of the same comprehension of all the details applies to the machinery of the Wampanoag. These engines were of the geared type, the engine shaft making less than thirty revolutions per minute, while the propeller shaft made over sixty. The reason for using this type of engine, which, course, was very heavy, was to prevent the destruction of the light wooden hull by the racking strains which would have been brought about by a direct drive of the shaft.

It has been mentioned that Isherwood investigated the subject of superheating, and the undoubted economy resulting from this method of working was established. It was to some extent used in American naval vessels, and the Wampanoag had a few single-furnace boilers which were known as superheating boilers. Superheating was tried also in the merchant service, but the *rationale* of boiler corrosion was entirely misunderstood at this period and the means to be adopted to prevent it were not properly comprehended. As a result the rapid destruction of the superheating apparatus by corrosion caused the abandonment of this otherwise valuable feature from the standpoint of economy.

Steam jacketing is as old as Watt, and, like expansive working, is included in the specifications of his patent of 1769. It was not, however, until after the period which we are now considering that jacketing was used to any great extent. The low steam pressures and limited range of expansion did not cause enough liquefaction to make the use of jackets show any marked economy.

One most important feature as regards economy was, however, introduced during the latter part of the simple-engine period, namely, the surface condenser. The early marine engines used jet condensers exclusively, and, as can be readily understood, this was equivalent to using feed water of the same degree of saltness as the injection water. With salt feed water there was, of course, a steady deposit of scale on the heating surfaces of the boiler, and this was a hindrance to higher steam pressures, thus acting to prevent an increase of economy. The use of salt feed had another distinctly uneconomical result, from the fact that owing to a misunderstanding of the *rationale* of scale formation a practice was followed called "blowing-off," the idea being to blow out of the boiler a certain percentage of the more concentrated water, which was replaced by the incoming feed. This loss was as great in some cases as 10 per cent., or, in other words, 10 per cent. of the heat imparted to the water was thrown away.

When the surface condenser was introduced the feed water was, barring leaks, fresh, so the blowing-off was stopped almost entirely and the loss prevented. As the incrustration was also prevented, there was no longer the fear of increased pressures on the ground of overheating the boiler surface, so that steam pressures immediately began to increase, accompanied by an increase in the ratio of expansion, with accompanying increase of economy.

It may not be out of place to say a word in this connection about the true explanation of scale formation when using salt feed. The principal ingredient in boiler scale from sea water is sulphate of lime, although this forms a very small percentage of the salts dissolved in the sea water. The old idea was that, like all other salts, this one would be more soluble in hot water than in cold, and it was supposed that the precipitation was caused by the evaporation and concentration of the water in the boiler. As a matter of fact, sulphate of lime forms an exception to the rule that most salts are more soluble in hot than in cold water, and it becomes almost insoluble when the temperature has risen to about 290 degrees Fahrenheit. This temperature corresponds to a steam pressure of about 45 pounds above the atmosphere, so that it will be seen at once that when pressures had risen to 45 pounds nearly all the sulphate of lime in the feed was deposited by mere elevation of temperature, and so far from blowing-off reducing the amount of scale, it simply increased it, because it necessitated a further supply of feed containing additional sulphate of lime. At the present day, when only fresh water is fed into the boilers, we no longer have the problem of scale on the fire heating surfaces, but special boilers, called "evaporators," (in which steam from the boilers going through a nest of tubes is the heat-carrying medium), are the only ones using salt feed. They are so constructed that the tubes are in nests which can be removed with great facility and very readily cleaned so that the scale in them gives no trouble.

It was mentioned above that one reason for the failure to adopt superheating in these early days was on account of the corrosion of the superheaters, and it may be as well to speak of the subject of boiler corrosion here, because, while the use of surface condensers obviated the difficulty from scale, simultaneously with their introduction there began great trouble from boiler corrosion. With that blind method of reasoning, which is not confined to engineering by any means, it was at once concluded that because two things happened at the same time one must of necessity be the cause of the other, and it was therefore assumed that the surface condenser had caused the corrosion.

The fact was that under the old regimen, when all the interior surfaces of the boiler were covered with scale, there was no chance for corrosion. When the use of the surface condenser left the boiler heating surfaces clean there was nothing to prevent corrosion occurring unless great care was taken to prevent it, and, as a matter of fact, the regimen adopted was absolutely certain to cause corrosion. All sorts of reasons were given to explain the occurrence. One theory was that the copper tubes in the condenser and the iron of the boiler formed poles of a gigantic galvanic battery, and iron being the electro-positive metal was the one to be corroded. Still another explanation was that the oil used for lubrication was decomposed with the formation of fatty acids which attacked the iron.

Still another explanation charged the corrosion to electricity, plainly without any attempt to explain how. The truth is that it was the treatment with the boilers received which caused the corrosion. It was the custom, particularly with naval vessels, where the corrosion was most marked, when a vessel arrived in port to blow all the water out of the boilers, and, after the steam had condensed, to take off the man-hole plates "to let the boiler dry." The researches of the chemists have shown that the active agent in corrosion is the carbonic acid of the atmosphere, which, in the presence of moisture and oxygen, forms compounds with the iron which are unstable and after formation break up, leaving the carbonic acid free to continue its work. Now, as will be seen, the treatment of the boilers left the surfaces moist and provided ready access for circulation of air so as to insure the presence of all three of the necessary agents. The truth about boiler corrosion was not discovered until a later period than that which we are now considering, but it may be said that what was known as the Admiralty Boiler Committee of Great Britain made an elaborate investigation of the subject, and in 1878 submitted a report which pointed out the true state of affairs and gave the remedy. This was to keep the boilers, when not in use, full of water made slightly alkaline, or, if practicable, to have the boilers thoroughly dried and provided with trays of unslacked lime to absorb the moisture. Since boilers have been treated with care and intelligence their life has been very much greater than in the old days, when they were, while ostensibly cared for, really neglected and abused.

The illustrations in this article, with the exception of the first, are from the excellent "History of the Steam Navy of the United States," by courtesy of the author, P. A. Engr. F. M. Bennett, U. S. N.

EMOTION AND REASON AMONG BRITISH WORKINGMEN.

By Percy Longmuir.

Speaking as an Englishman, but possessing a thorough knowledge of industrial conditions on the Continent and in the United States as well, Mr. Longmuir touches a vital point when he emphasises the close relation which exists between emotion and popular opinion among British workmen. The need for the substitution of reason for the mere influence of emotion is well brought out in his thoughtful words, addressed to workingmen of his own as well as of all lands.—The Editors.

IN a former article on "The Home Environment of British Workingmen," social, educational and workshop limitations were discussed; in the present one I propose to examine the effect of emotion on industrial lives. The subject may be viewed from many standpoints, and the construction of any one view will naturally vary with the viewpoint; therefore an effort will be made to examine general effects and to avoid as far as possible all side issues. At first glance, the idea of an emotional environment in mill, forge, or foundry practice seems absurd and altogether out of place. What can be more prosaic than rolling mill or forge conduct of today? And yet the means taken to effect successful conduct of any department of industry depend to a vast extent on human units, subject in large measure to emotional feelings and passions. One effect of an exercise of unrestricted emotion is for a time to retard progress and to hamper invention. Many an industrial innovation has had the hostility of the workers to fight, not a few have had the combined hostility of masters and men to combat, before meeting with just recognition; and there are on record struggles of exceptional keenness between new methods on the one hand and combined or vested interests on the other. The cotton industry and the steel tradeoffer examples of such conflicts and these in turn give as much material for study and digestion.

In examining the extent to which emotion replaces reason, the effect on the industrial class only will be considered. The average British workingman believes that because he is a Britisher he is industrially superior to the workmen of any other nationality, and the very fact of being so places him in a position unassailable by any foreigner. Therefore when he hears of foreign competition, or by chance reads an article on it, he scorns all the facts of the case and shelters behind time-worn excuses or time-honoured unbelief. American ship-building or locomotive making, German electrical-engineering—are to the majority myths or fables, and in the comparatively few cases where they are acknowledged to be worthy of notice it is only half-heartedly and with a qualification that British workmen are taking the chief share in such foreign enterprise. To have hitherto led the van in the progressive march is no guarantee that we always shall do so, but the effect of this leading has been to instil into industrial minds the fixed idea that this position is permanent and is as the laws of the Medes and Persians, which altereth not. This assumption is not based on thought or knowledge; it is formed without any study of either current events or of the annals of our own glorious past. The records and lessons of that past are a sealed book, the sole idea at present being that we Britons as a nation have always been first, and owing to the supreme fact of being British always will be so, as though the accident of birth were always to determine racial priority. Natural advantages of other countries are ignored, and the only thing acknowledged is in a broad manner that the success of Britain's competitors owes its first inception to British labour. National tradition is a stimulating and inspiriting force. It is the backbone of a patriotic constitution and as a force alone will in cases of emergency move men to superhuman effort. But of what use is a national tradition in the form of a hazy notion of superiority, with no conception of what has been, of what now is, or of what will be the essential features in this scheme of superiority? Did we but recognise the truth of the saying current in the sixteenth century:

> "Our fathers that had more wit and wisdom than we."

and act upon it, then there would be comparatively little need to talk of an emotional environment as a factor of industrial matters. If we, as workingmen, studied "our fathers" earnestly and with strenuous endeavour tried to grasp the lessons of their industrial lives, then, and then only, could we take a share in the pride of the achievements and glories of a bygone age. This pride, founded on knowledge and associated with the moving spirit of the age, would contrast very strangely with the present hysterical emotion based on ignorance, formed without judgment, and believed in with the most implicit faith by multitudes of the working classes. Industrial workers are, however, not alone in this respect. A comparison of passing events will show that similar mistakes are repeated generation by generation, with most faithful accuracy and often painful results, by other classes presumably acquainted with historical facts. National tradition, then, if it teach anything at all, should give us in addition to a just and proper pride, also a fit recognition of the non-infallibility of average human judgment as represented in a collective nation. Given this true spirit of national pride, we could then hope and work for a continuance of national greatness. The efforts made for the maintenance of this position would be founded on actual knowledge, and in progressing, valuable effort and energy would be conserved, not fruitlessly consumed in time-worn errors of judgment. This spirit, in full keeping with the progress of our own nation, would also be in sympathy with the advance of other nationalities; it would replace the present one of scornful, not to say hostile, indifference, with an eager desire to use all fair means as steps in the progress of national development.

Passing from national to more local types of emotion, we find it exhibited in many forms and various degrees of intensity. In its better aspects it may be seen in collections heartily and generously supported for the relief of some unfortunate fellow worker; equally impulsive, but not always so commendable, in the form of a sudden cessation of work by large numbers of men owing to some change in method of work, the introduction of a new tool, or possibly the appearance of a non-unionist amongst the ranks of the workers. Very insignificant changes often result in spontaneous outbursts of this kind; at other times the changes proposed have to be of a more drastic nature before resulting in an exhibition of this feeling. At any rate, it is certain that the depth or intensity of the emotion displayed on such occasions is not in any way proportionate to the change proposed, for usually the slighter the change, the greater the opposition it has to face. Emotional feelings are by their very nature extremely erratic, and in natures in which these feelings replace conviction it is difficult to estimate either their depth or intensity. Take, for instance, the case of an average manufacturing town possessing two prominent football teams, each of about equal merit, and examine the followers of these respective teams. Can it be said that they have thought out the merits or qualifications of either club and are therefore following and supporting a conviction? Hardly that—yet these very same supporters in thousands will follow and blindly swear by their own tin god to the exclusion of all reason or common sense. Saturday afternoons in any North-country manufacturing town of Britain fully demonstrate this assertion. It is the same, though possibly to a more temperate extent, with cricket—impulse, not choice, in most cases marks out the path for the average individual to follow. Horse racing is perhaps a more typical illustration. In shop parlance, a man "backs his fancy" and let his knowledge of that particular horse be what it will, it is always on his fancy that his money is laid. The British workman is often accused of devoting more thought to sport than he does to actual work, and therefore these matters of cricket, football, and racing have been mentioned in order to show that on subjects on which he is so presumably thoughtful, it is still fancy or emotion which guides him.

Emotionalism degenerated into a pet localism is shown in town rivalry. A healthy spirit of rivalry may be conducive to progress, but the rivalry which persecutes a fellow workman because he hails from another town is a mean contemptible thing. "Can any good thing come out of Nazareth" expresses well this feeling of town rivalry. Observe the contempt in which Birmingham workers are held in the North. Ask a Clyde or North-East Coast brass moulder what his fellows in Birmingham chiefly produce, and he will in all probability reply "soldiers' buttons." On the other hand, these "button makers" have an idea that their *confrères* of the heathery land are in very fact northern barbarians. This spirit, due entirely to accident of birth and environment, is greatly rounded off by travel and work in other towns. A man who has worked in three or four localities is—other things being equal—of a far more developed type than one who has never been beyond the conditions into which he was born. In all cases a sharp distinction must be drawn between just pride in either a town or a well thought out cause and a hysterical emotion founded on air bubbles.

It naturally follows that the emotional balance of an industrial mind is determined by various simple and complex causes. We have seen the effect of inclination, whim or fancy in the case of recreations, and these factors are none the less powerful in the case of industry. Apart from these, daily occupations, especially when of routine character, tend to fix the emotions in a narrow groove. Under such conditions, accompanied as they so often are by narrow home surroundings, the outlook and scope are limited and the narrowing effect is seen in violent opposition to change or advance. This limitation of outlook assures the individual that any advance must mean eventual scarcity of work and consequent misery to himself, and therefore acting according to his light he opposes that advance with all the blindness and obstinacy usually found when reason is absent. The policy of trades unionism may to some extent foster this view, but it receives its chief development in actual suroundings and circumstances of the individuals themselves.

Routine occupations combined with monotonous and never-changing surroundings effectually develop and intensify pet localisms of the mind; mental effort becomes a weariness, perceptions are limited by environment, and emotional feeling settles all matters requiring the exercise of judgment or reason.

Political opinions, if honestly formed as the result of study and thought, would have an exceedingly beneficial effect. Within certain limits these convictions would broaden the minds, given a wider outlook, and assist in the formation of a truer estimate of the actual conditions under which we live. In such a manner political opinions could be utilised and trained in a purely educational spirit. Contrast this educational force as it might be, with political conduct as it is actually practised. We have leaders, so-called, pandering to the emotions and flattering the tender susceptibilities of the multitude. Leaders in the true sense of the word they are not; they neither lead, educate, train, nor direct, and they obtain recognition by a suitable handling of the plastic material of their constituency. It must be regretfully confessed that political as also trades-union leaders do not in any way rise to the height of their opportunities of directing opinion into legitimate channels of thought, and so training the workers to realise in themselves the best that their position can afford. At the same time, it must be admitted that a so-called leader can hardly, by the very nature of things, lead or guide; in most cases necessity compels him, if he wish to maintain office, to follow his flock—he simply voicing their demands. Hence leaders, instead of interesting their followers in vital matters and directing that interest to ever widening planes of thought, are compelled to play upon the excitement and at times the passions of their constituency. This exploitation of the excitable feelings is responsible for much backwardness, it hampers education, retards advance, and to a large extent prevents our taking a leading part in the evolution of industry.

Times change, new facts are observed, scientific discoveries are brought within the reach of practical industry, and methods of work are revolutionised by the research and effort of advancing pioneers. To what end all this diligent and painful effort, unless it be combined with the accumulated experience of the past and result in the advancement of our industrial army as a whole? It is for them, if they have their own and the nation's welfare at heart, to apply in all heartiness and sincerity the new facts of research and experience. According to some sections of public opinion and of the daily press one would think that every advance made by another nation means a corresponding recession on the part of Britain. This is not necessarily the case; it denotes neither commercial decay nor yet growing inferiority on the part of British workingmen, but it is simply a necessary factor in the evolution of that particular nation making the advance, and as such must be recognized as a factor of national development. An ideal spirit would admire progress wherever found and irrespective of nationality; therefore let us in all honesty give credit when due. Of what profit is it to call into the hysterical emotion so often exhibited on occasions when contracts leave British shores? What possible good can come by so lifting up our voices in a world-wide wail? Let us keep our wailing for the closet, and in public life we will be up and doing, nerving every fibre to maintain present and create new positions of industrial or commercial utility. But in this nerving for the tension of a keen fight, every effort put forth must be wholesome and sound, and given a fair field and no favour we can leave those efforts to that supreme test of all—the survival of the fittest. And should it be found that other nations are more fit than we, then let us, pocketing a lesson with the defeat, in all manliness give them the credit of well-won victory.

But before such a spirit can be inculcated into the minds of our industrial workers, something almost approaching a revolution in the method of thought (or should I say, lack of method of thought) practised by them will be necessary. Crippling environment or circumstances that tend to warp the judgment and narrow the outlook of multitudes of our workers must undergo renovation or removal. It is an easy matter to suggest reform, but to effect it is quite another story, and therefore no elaborate schemes are here outlined and the suggestions are from a purely utilitarian point of view. As outlined in a former article, a thorough-going education continued to a reasonable age is essential. This education, not necessarily technical, is to aim chiefly at the production of a sound child, one who in after industrial life can apply his training in the resolution of cause and effect. It is to be hoped that the near future will see this or a similar system in operation for the children of the industrial classes of Britain. But there are many forces already existing, quite apart from evening classes or similar effort, which might be turned to beneficial account in the training of those beyond school age. The extent of emotionalism has in a limited manner been indicated; it pervades alike industry and recreation and the only antidote is a sharp return to actual matter of fact. Let this return take place in matters of recreation alone and an improvement in public spirit will soon follow. Back to the facts of sport—discard professionalism and let class meet class on the levelling ground of cricket or foot-ball field.

The pluck and endurance of British nationality were not built up by spending all available Saturdays in watching paid professionals kick the ball. Can one imagine a better tonic for a week of dreary toil than some keenly contested outdoor game? And what more invigorating or better likely to assist in keeping that balance of mind for which we were once so famous?

Trades unions or political organisations offer wide scope for the development of an intelligent interest in industrial or economical progress, national welfare and general topics of the day. Keep to solid facts, no matter what particular views may be taken, and instil into minds at present comparatively unoccupied a desire to be *au courant* with current industrial, political, and social topics, and emotion receives its death blow. Cultivate an interest in historical matters, especially industrial ones, and a just national pride will replace the present "Mafeking" sentiment that now passes as such. Let us in all things come down to current facts, endeavour to understand and grasp problems of our times, and such an understanding will keep us, while moving onward, firm on the bed-rock upon which alone true progress is based.

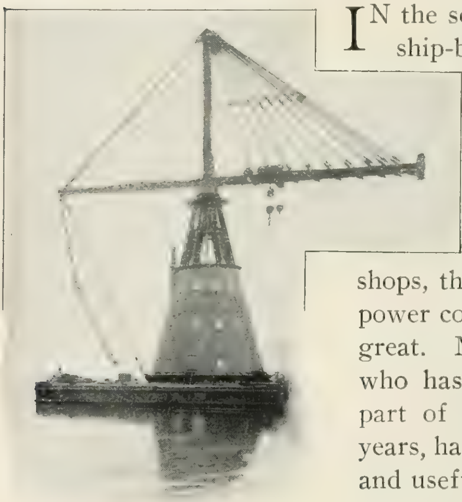
In this endeavour to keep to facts we have, in the just-completed Victorian period alone, a wealth of opportunity and assistance in its invaluable literature. These prophets, teachers, and thinkers are available to any working man in Britain today, and on his own shoulders rests the responsibility as to whether he take the chance or no. Many opportunities are to hand, let him rouse himself and grasp those within reach and then others are bound to follow. The first effort must come from the worker himself, and it is for this effort that the progress of British industrialism is now waiting. Will that effort be forthcoming?

Assuming that this effort be made, assuming that trades unions and other organizations take full advantage of their opportunities for education and that the various agencies at work create a body of industrial workers famed, apart from skill of handicraft, for their common-sense and balance—then in very truth the future holds for us in one respect at any rate a "thornless rose" and industrial progress and development are assured. But this thornless rose is based on assumptions which may or may not be realised.

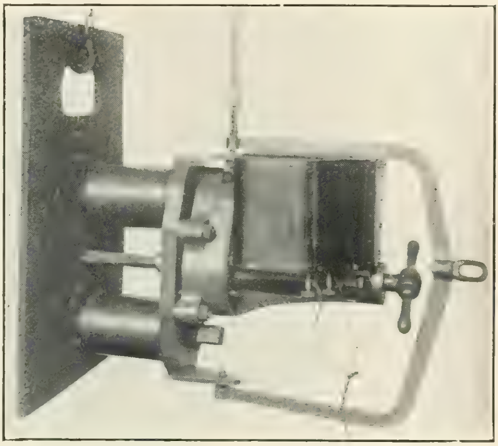
ELECTRIC APPLIANCES IN SHIP-BUILDING YARDS.

By Sydney F. Walker.

In a preceding paper, Mr. Walker discussed the general uses of electricity in ship-building yards and the driving of fixed tools and large apparatus. In this paper he takes up more particularly the smaller portable tools for operating on work *in situ,* the transporting machinery, and the generating plant.—The Editors.



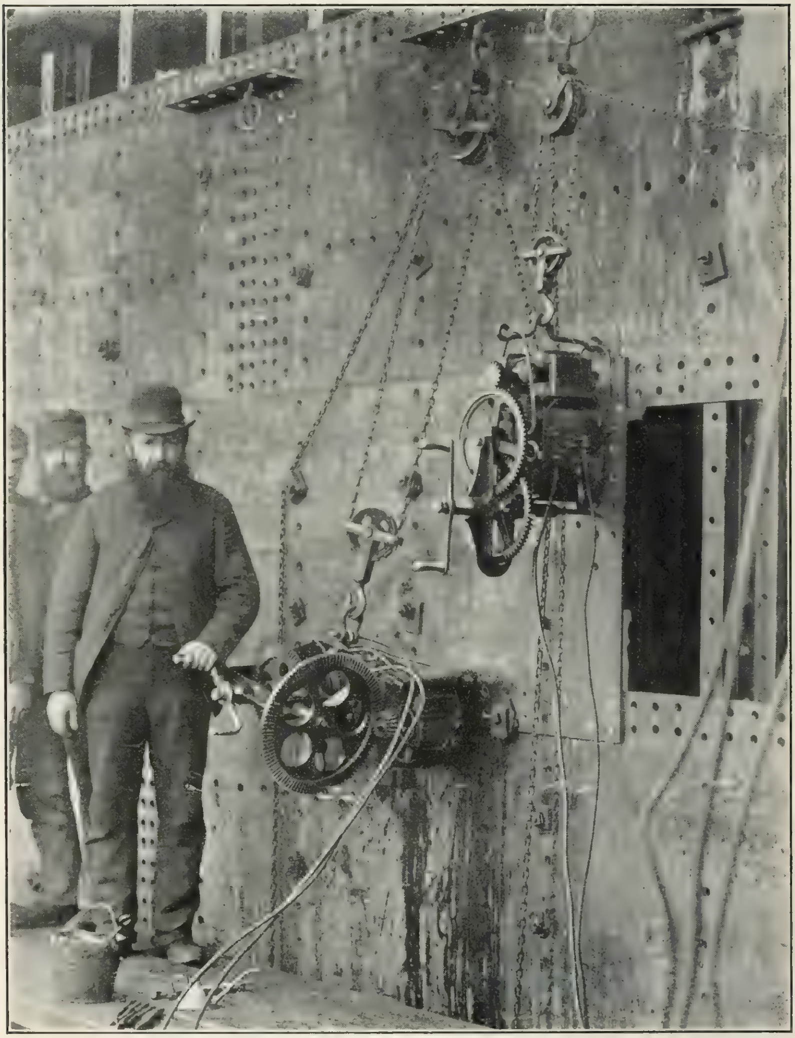
IN the second opening for electricity in ship-building yards—the operation of small tools designed to perform work upon the different parts of the ship *in situ*—there is a much wider scope than for driving the large machine tools in the workshops, though the aggregate amount of power consumed by these tools is not so great. Mr. F. J. Rowan, of Glasgow, who has given great attention to this part of the subject for a good many years, has produced some very ingenious and useful portable tools driven by electricity, which have been in use on the Clyde and in other districts for some time and have done good work. His electric drilling apparatus and electric rivetting apparatus, which are shown in the illustrations, were brought before the Institution of Mechanical Engineers in 1887, and were subject to a somewhat amusing criticism. Some of the speakers thought that it would be dangerous to employ electricity and magnetism in the manner proposed in the work upon the plates forming the side of a ship, as it would probably affect the working of the compasses when the ship took the sea. If the critics had known that to get a piece of steel to retain the magnetism which is put into it, for certain purposes, is one of the most difficult problems the electrical engineer has to deal with, their minds would have been quite at rest. In a case like this, where the electrical apparatus is being constantly moved about, a few inches at a time, any magnetism that might have been created would be instantly wiped



A PORTABLE ELECTRIC DRILL, ROWAN TYLE, DRILLING A PLATE SWUNG LOOSE.

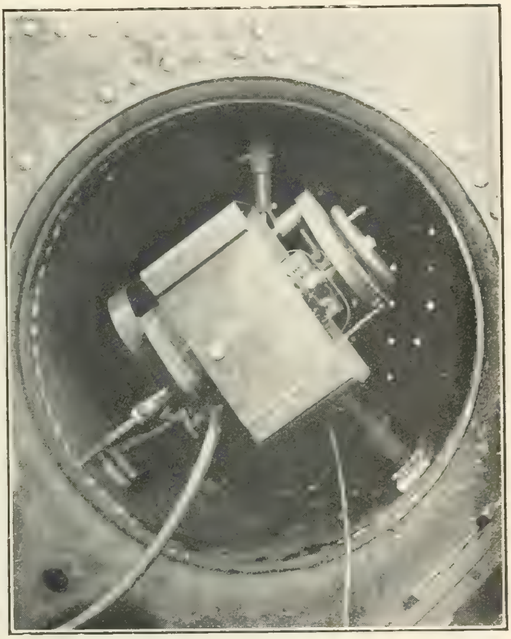
out, even under the worst conditions. In Mr. Rowan's apparatus, the electromagnet is very ingeniously made use of to hold the tool in its place against the work it is operating upon. As will be seen from the illustrations, the apparatus consists, both in driller and rivetter, of two distinct portions held together. An electromagnet, with its two poles free, holds the tool against the plate or bar to be drilled, the work itself forming the armature of the electromagnet, or, in modern parlance, completing the magnetic circuit, while the electric motor, which is held by the same framework which holds the electromagnet, turns the drill through the usual gearing. With the rivetting machine, there are two variations of this arrangement. For rivetting, the tool not only requires to be held firmly on the work that is being done, but the work itself requires to be held together while the rivet is being made secure. For this purpose Mr. Rowan has again adopted very ingenious means. He provides two electromagnets, one in the same position as with the driller, on the side of the rivetting tool, the other on the opposite side, where a workman would be placed in hand rivetting to hold up against the hammer. The effect of the two electromagnets with the plates between them is to hold the two plates or bars very closely together, and this position can be maintained until the rivet has cooled sufficiently not to alter in position after the plates are released. It is claimed that rivetting by percussion is quite as effective as by pressure, as in hydraulic rivetting, provided that the plates or bars are held together in the position in which the rivetting has been performed until the whole has cooled.

In the early form of rivetting apparatus, Mr. Rowan provided a strong spiral spring, which was wound up by the electric motor and which struck the blow, the winding up and release taking place in rapid succession, according to the number of blows required per minute. Machines are made on this plan slightly modified now, but Mr. Rowan prefers to use either compressed air or steam for the striking



TWO OF ROWAN'S ELECTRIC DRILLING MACHINES AT WORK ON A SHIP'S SIDE.

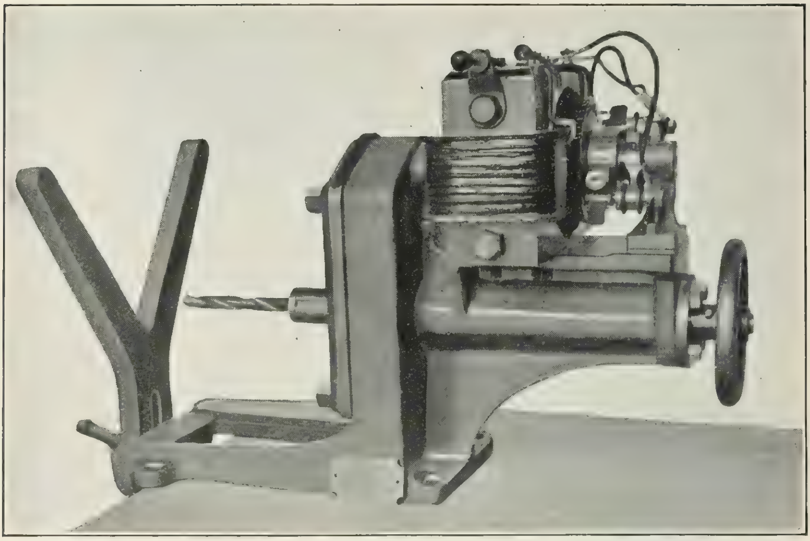
mechanism, a cylinder and piston being arranged for the purpose as shown in the illustrations, and to use the electric current only for holding the tool in its place. He is also enabled by this arrangement to work the rivetting tool at any angle, so as to take the head of the rivet under all conditions, and notwithstanding the inaccuracy of the holes punched. It will be seen what a very useful adjunct to the machine tools in ship-building are light portable tools of this description. Punching, as mentioned above, is often inaccurate; holes often require to be drilled in all sorts of positions where it is very difficult to get machines to work, and where hand labour would cost very high owing to the awkward position in which the man would be working. With this apparatus, holes can be drilled or rivetting, etc., can be performed in any position. The illustrations show the operations of drilling the inside of boiler flues and also the outside of ship plates. With the same apparatus, slightly modified, caulking is performed by a wheel, the wheel acting under pressure.



ROWAN'S PORTABLE ELECTRIC DRILL AT WORK INSIDE OF BOILER FLUE *in situ.*

A somewhat similar tool, of the portable variety, is that shown in the illustration; it is for cleaning up castings by means of a travelling emery wheel. This apparatus can be held in any position where it is required to work upon iron or steel, in any part of the ship, and can also be used in the machine shops. As will be seen it is driven by an electric motor.

Other portable tools, electrically driven, are shown in the drawings. Notable is the electric deck-planing machine, arranged to be wheeled about on a hand truck, similar to those used for carrying sacks of corn, coal, etc. The motor and gearing are contained in an iron box, the cutting knives being underneath, driven by transmission at the side, from the electric motor pulley. On the handles are also fixed the starting resistance and switches, so that the workman using the tool has everything convenient; he can stop or start the machine at will, and he just runs it over the deck surface as he might a sack of coals, but with less exertion and with greater care to see that he is planing all right. Another very useful class of portable tools of which there are many on the market are the portable drilling machines, of which specimens are shown in the illustrations. The arrangement is practically the same in all cases, with variations in matters of detail.

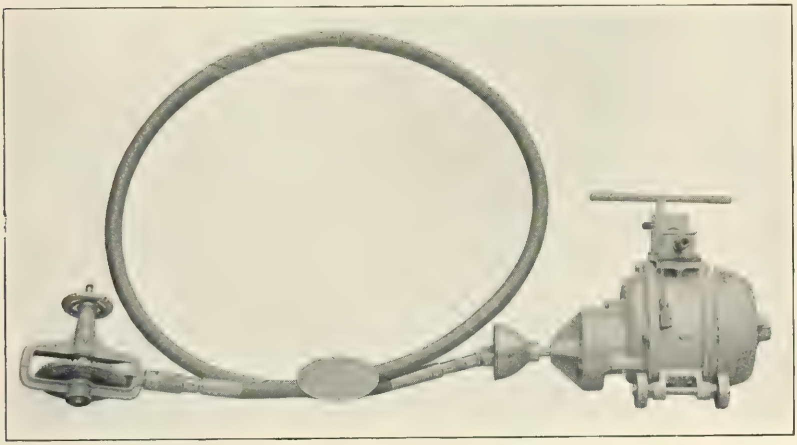


ROWAN'S PORTABLE ELECTRIC DRILL AS APPLIED TO WORKSHOP USE.

An electric motor is mounted on some sort of barrow or trolley, with handles by which it can be run about. To the shaft of the motor is attached either a flexible or telescopic shaft, and this is connected to the drill, the latter being held in some form of vise which also holds the drill up to the work.

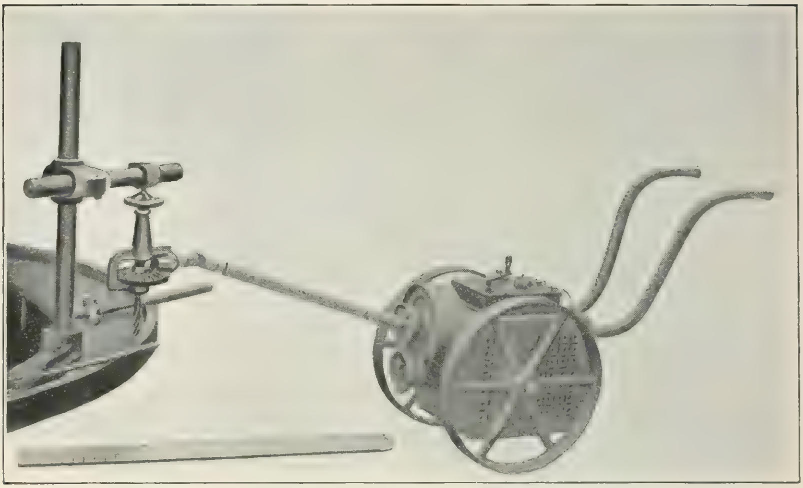
The third portion of the useful work done by electricity in ship-building yards consists of the transporting and lifting apparatus. Cranes are in use all over ship-building yards, and they are now nearly all driven by electric motors, when once a power station has been installed. In a large number of cases the old steam cranes have merely had their steam engines removed, and single electric motors substituted; but wherever new cranes have been put in, the flexibility of the electric motor, which was referred to above, has been taken advantage of and three motors provided, one for the hoisting and one for each motion of the crane itself. Electric cranes are usually now provided, sweeping the whole length of the building shed and the whole length of the machine shops as far as the presence of belts and shafting will allow, and as belts are done away with by the continued subdivision of the driving, the overhead crane, electrically driven, more and more reigns supreme. Foundries and other places of which there are many where ship-building operations are progress, where heavy weights have to be lifted and transported, also have overhead cranes, electrically driven. About the ship itself, while in progress, are many smaller cranes, winches, and capstans, which are now being electrically driven as shown in the illustrations, all that is necessary being the removal of the steam engine and the fixing of the motor and gearing.

Electric locomotives do not yet appear to have taken their place in ship-building yards in Britain, but doubtless they will follow. The arrangements necessary for taking current from overhead trolley wires will be inconvenient at first, and managers will naturally be chary of having naked wires with 500-volts pressure alive about the works; but as the men become accustomed to the presence of electrical apparatus, and learn to respect high pressures, it will be possible to use many apparatus that are now impracticable. The development of the electrical accumulator also will enable electric locomotives to be employed without these dangers.



PORTABLE ELECTRIC DRILL WITH FLEXIBLE SHAFT.
Greenwood & Batley, Leeds.

There are several other apparatus in which electricity is employed in ship-building yards. Pumps for the dry-dock, which is a part of the modern ship-building yard, are driven by electric motors, and also pumps for the boilers and for various other purposes. The lighting plant in most modern ship-building works is also electrical, arc lights being freely used about the yards, with incandescent lamps in positions where arc lamps are impracticable; and it is a striking illustration of the development of the use of power distribution by electricity, that instead of driving the lighting generators by separate engines, they are in many cases driven by electric motors from the main electric-power service. Practically, what is done is this:—motor-generators are put down, taking their current from

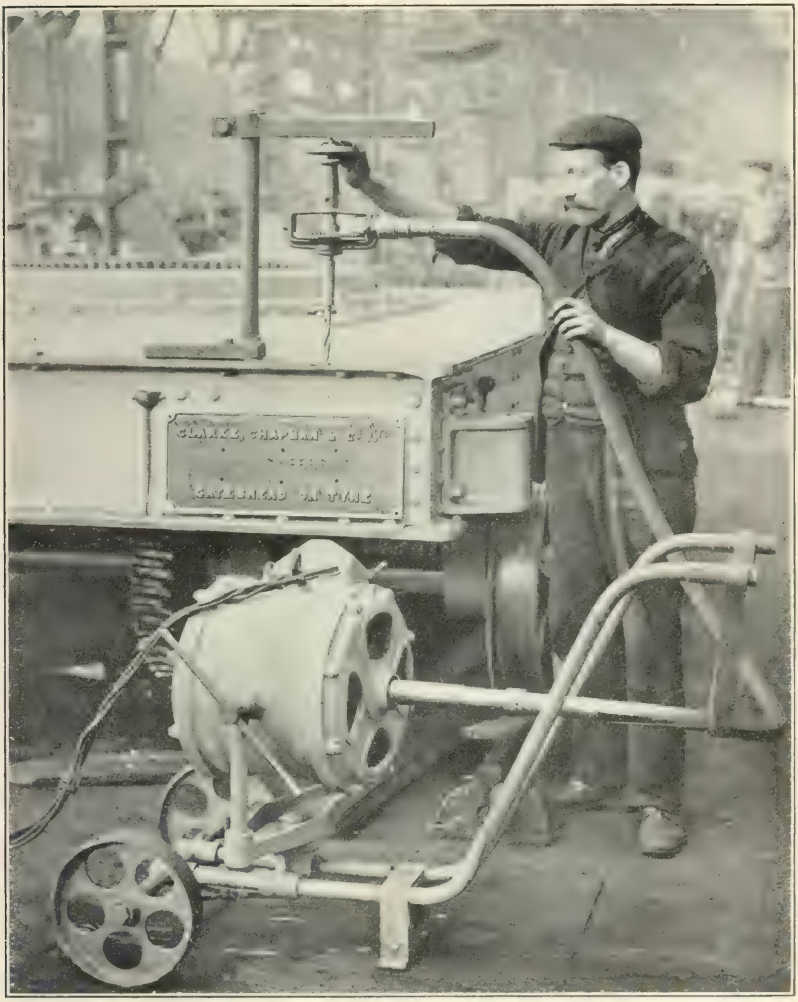


A PORTABLE ELECTRIC DRILL WITH UNIVERSAL-COUPLED SHAFT.

Mavor & Coulson, Mile End, Glasgow.

the supply service, at the pressure and in the form ruling, and delivering it to the lighting circuits in the form required for them. This is again a striking illustration of the flexibility of electricity. At present, if an electrical engineer is given an electrical plant in any form and he is also given what other plant he asks for, he can produce current in any form that may be required, in any place, within very wide limits.

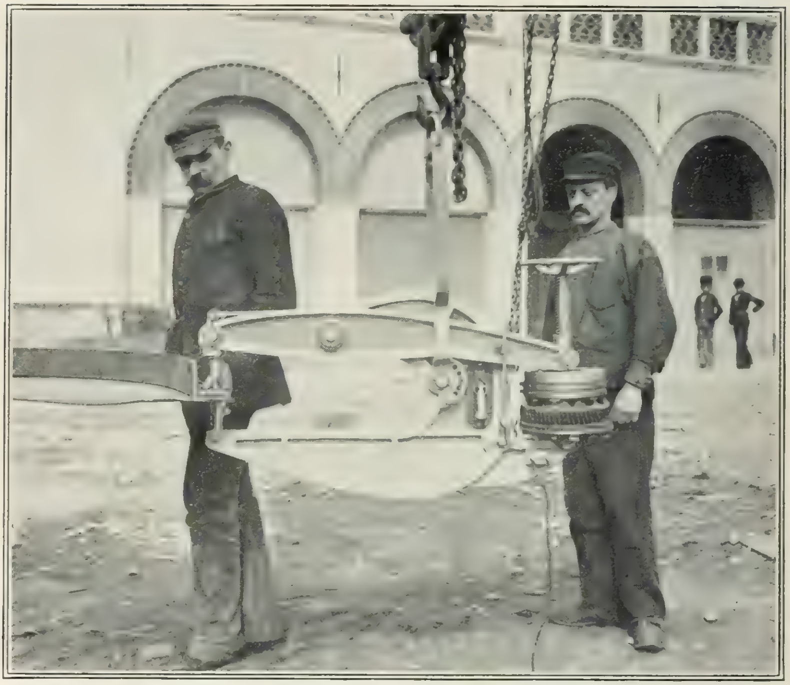
But perhaps the most striking feature of the advance by which electricity is pushing its way into every branch of engineering is the fact that it is actually employed as part of the plant in connection with compressed air, and with water-worked apparatus. Where an electric power service exists, it is frequently employed to drive the air-compressing plant supplying tools and other apparatus using compressed air. And in one case at least it is employed to pump water for a hydrostatic tool, as shown in the illustration of the hydrostatic press made by the Niles Tool Co. The hydrostatic press is an apparatus employed to force wheels and similar pieces of apparatus upon the shafts or axles on which they are to run. In ship-building it is employed to force the crank onto its shaft, in those cases in which the crank shaft is not made from one forging. The crank portion is placed in a rest, a holder provided for it where it is held firmly, and the shaft is forced into the aperture made for it in the end of the crank, by means of a ram worked by a piston with water pressure behind it. The water pressure is produced by means of a pump carried



A PORTABLE ELECTRIC DRILL WITH FLEXIBLE SHAFT; TWO-PHASE MOTOR.

on the tool frame itself, the pump forcing the water, when required, from a tank below into the ram behind the piston. In the tool shown, the pump is driven by an electric motor. There is no reason why the pumps for the hydraulic service should not be driven by electric motors. It will be economical and convenient, and it will lead the way to the further change—the performance of all the work by electricity.

Another portion of the work of a ship-building yard, as well as of other industries that will in my opinion be done in future years by electricity, is the heating of the different portions of the ship—the

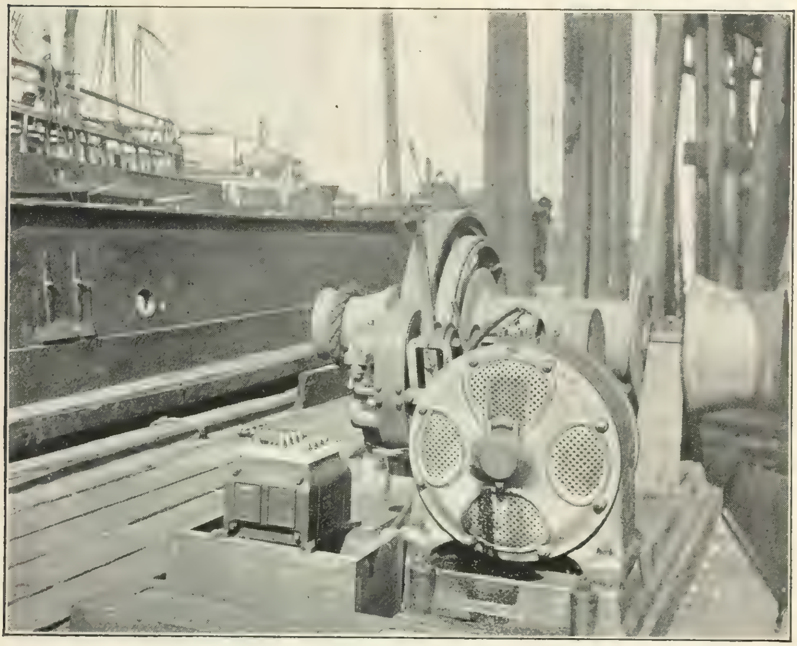


PORTABLE ELECTRIC RIVETTER AT WORK IN A CONTINENTAL SHIP-YARD.
Kodolitsch system. By courtesy of Mr. F. S. Dudgeon.

plates, bars, etc., which have to be heated before they can be bent to the required forms. The method at present employed is clumsy compared with electric methods, and though it will probably be thought by practical ship-builders the dream of a visionary, I have seen so many dreams come true during the last twenty-eight years that I have been engaged in electrical work, so many of the prophecies for which I have been roundly laughed at have become accomplished facts (and in many cases, in the hands of the very men who laughed,) that I have no hesitation in again venturing into the dangerous field of prophesy.

I believe also that the problem of protecting ship's bottoms from the action of sea-water will be solved, more effectually than it is now, by depositing the protecting metal upon the iron by electricity. There are, as in other cases, difficulties to be overcome in this matter apart from the practical difficulty involved in arranging the enormous depositing bath required for the purpose. Deposited metal is porous, unless hammered afterward; but this will be overcome as so many other difficulties have been during the past twenty-five years.

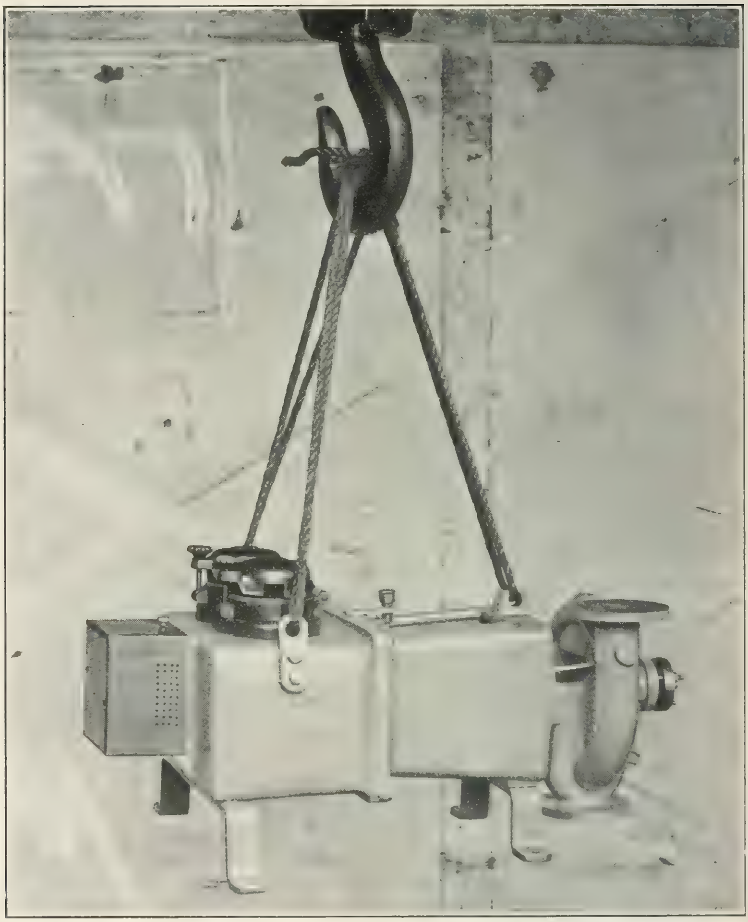
I believe that I cannot finish this article better than by describing



WINCH DRIVEN BY WESTINGHOUSE THREE-PHASE ELECTRIC MOTOR, PALMER'S SHIP-BUILDING YARDS, JARROW-ON-TYNE.

an installation of electric power that has been recently put in at the historic works of Messrs. Palmer, at Jarrow-on-Tyne. Messrs. Clarke, Chapman and Company and the British Westinghouse Company have carried out the installation together at the works of the Palmers Ship-building Company, the Westinghouse Company providing the larger motors, the switchboard, and some accessories, and Messrs. Clarke Chapman doing the work and supplying the remainder of the apparatus.

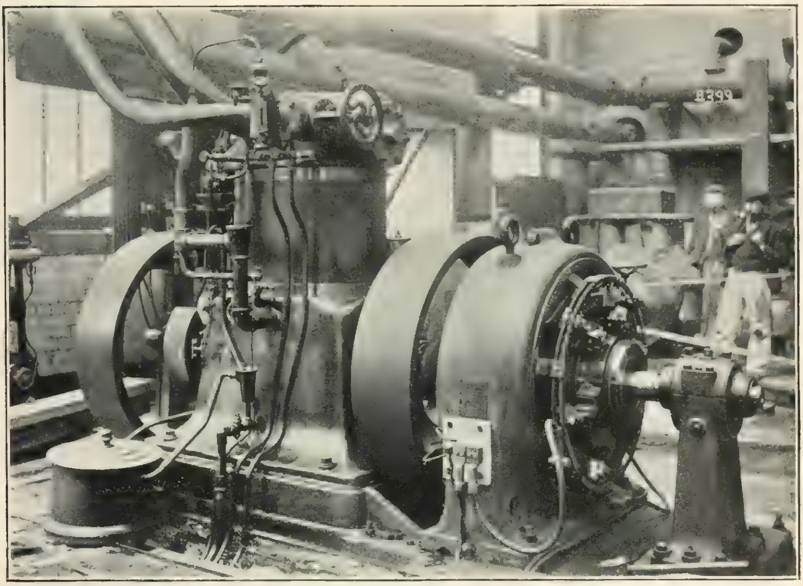
The installation is virtually a power station, as large as many central stations in large towns. The whole is carried out by means of three-phase alternating currents. Two Westinghouse three-phase generators, of 750 kilowatts output, are directly coupled to triple-expansion open-type marine engines of 1,000 horse power, the speed being 160 revolutions per minute, the electrical pressure 440 volts, the boiler pressure 150 pounds per square inch. Engines and dynamos are connected together by flexible couplings, and have flywheels 11 feet in diameter between them, the flywheels being carried by a separate set of bearings. The alternators are of the rotating-armature type, the field magnets consisting of twenty-two laminated pole pieces,



PORTABLE ELECTRIC PUMP FOR USE ON BOARD SHIP, DURING CONSTRUCTION.

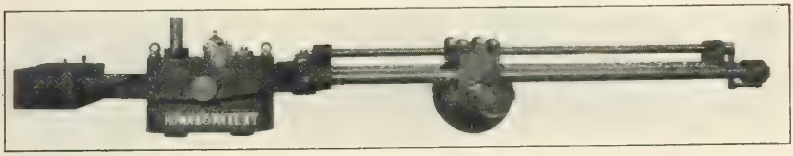
The apparatus consists of a small enclosed motor direct connected to a centrifugal pump, and may be slung into position as needed. Clarke, Chapman & Co., Gateshead-on-Tyne.

cast into a containing ring in the usual manner. Two continuous-current machines, driven by Westinghouse compound engines, provide the exciting current for the alternators. The exciter generators are of the same construction as the alternators, having six poles instead of twenty-two, and being arranged with commutators, and for continuous current instead of for alternating. A separate power house is provided, with the boiler portion divided from the engine and dynamo portion, as is now usual. One hundred and four motors are fixed, all of the three-phase induction type, in which the motion of the rotor is obtained by the revolution of the magnetic field round the outer con-

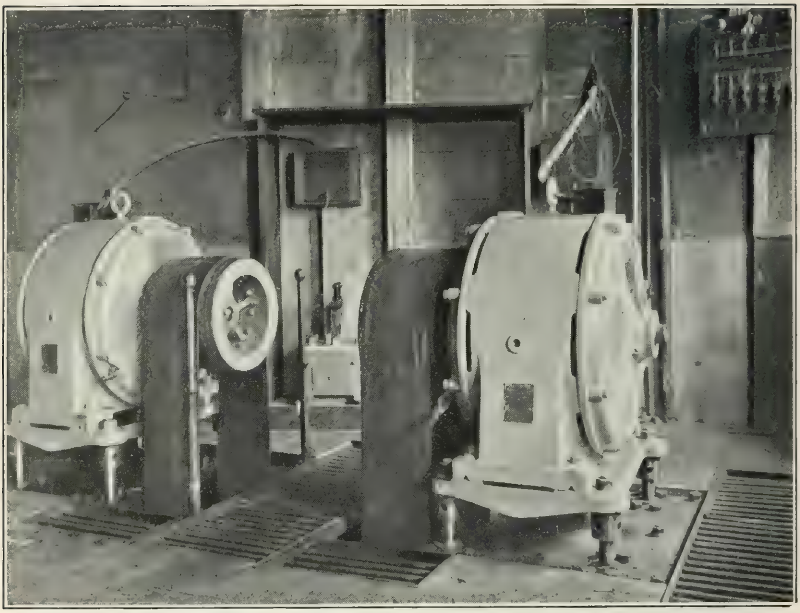


WESTINGHOUSE STEAM-DRIVEN EXCITING SET, PALMER'S SHIP-YARDS, JARROW-ON-TYNE.

taining ring. The motors are of the usual Westinghouse type, the smaller one, those of 20 horse power and below, being made by Messrs. Clarke Chapman & Co. on Tesla's patents, under license from the Westinghouse Company. The aggregate power of the one hundred and four motors is 1,750 horse power, and they are used to drive lines of shafting, large machine tools of various forms, cranes, winches, fans, pumps, and, in fact, to do all or very nearly all the work of the yard and shops that was previously done by steam conveyed to all parts of the works. Power is distributed to the motors by a system of three-cored cables, the individual cables being insulated by vulcanised rubber, braided over all and covered with lead. The major portion of the cables is laid underground, but a portion is carried overhead, and in that the lead covering is omitted, the completed cable being covered with marline. A five-panel marble switchboard is fixed in the power house, two panels for the generators, which can be run in



EMERY MACHINE WITH TRAVELING WHEEL FOR DRESSING LARGE STEEL CASTINGS.

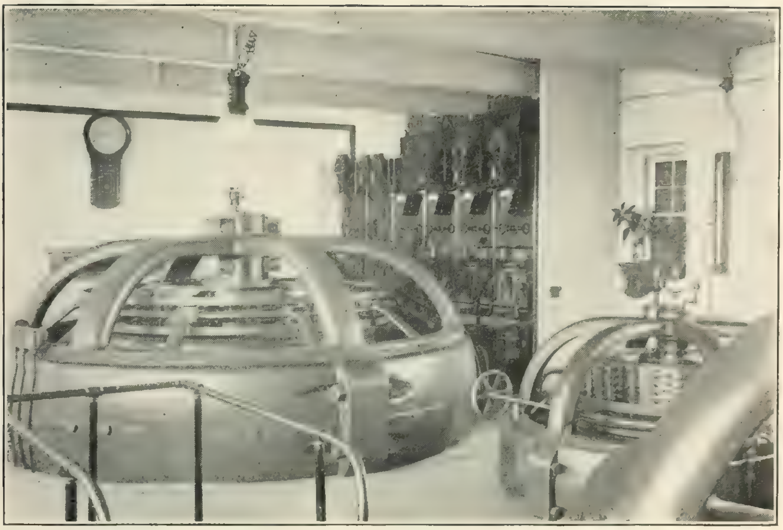


WESTINGHOUSE THREE-PHASE MOTORS OPERATING DRY-DOCK PUMPS, PALMER'S SHIP-BUILDING YARDS.

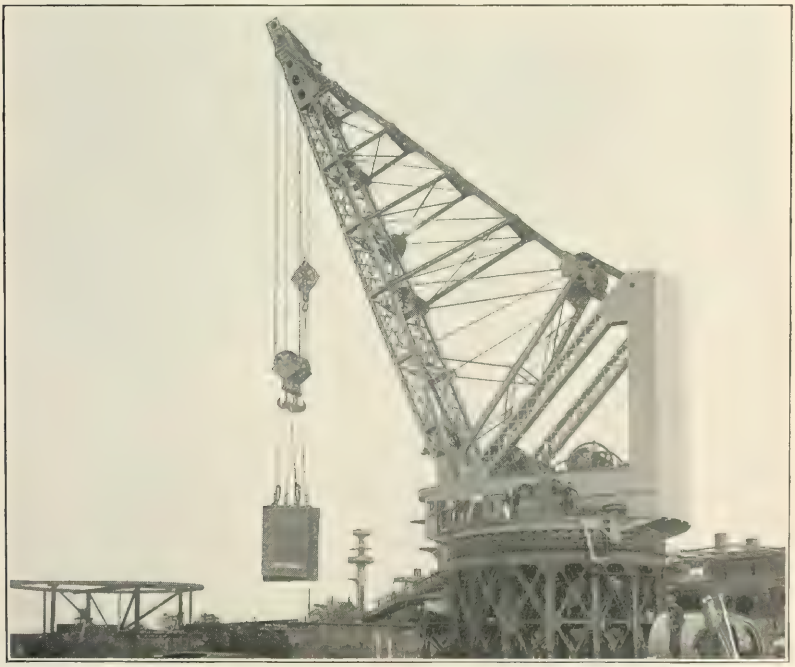
The pumps are below, and are belt-driven from the motors.

parallel or independently, two for the main cables, and one for the exciter circuits. From the main switchboard two main circuits are taken, each consisting of three cables, each of 0.33 square inch section. One main cable is taken to a main distributing switchboard in the machine shops, from which five branch feeder cables, of the same pattern as the main cables, are taken to branch distributing boards, and from these further cables on the same pattern are taken to the neighbourhood of the motors, where the starting arrangements are located. The other main cable is carried to a main distributing board in one of the sheds, from which eleven branch distributing cables are carried to as many branch boards, from which again branch cables run to the motors.

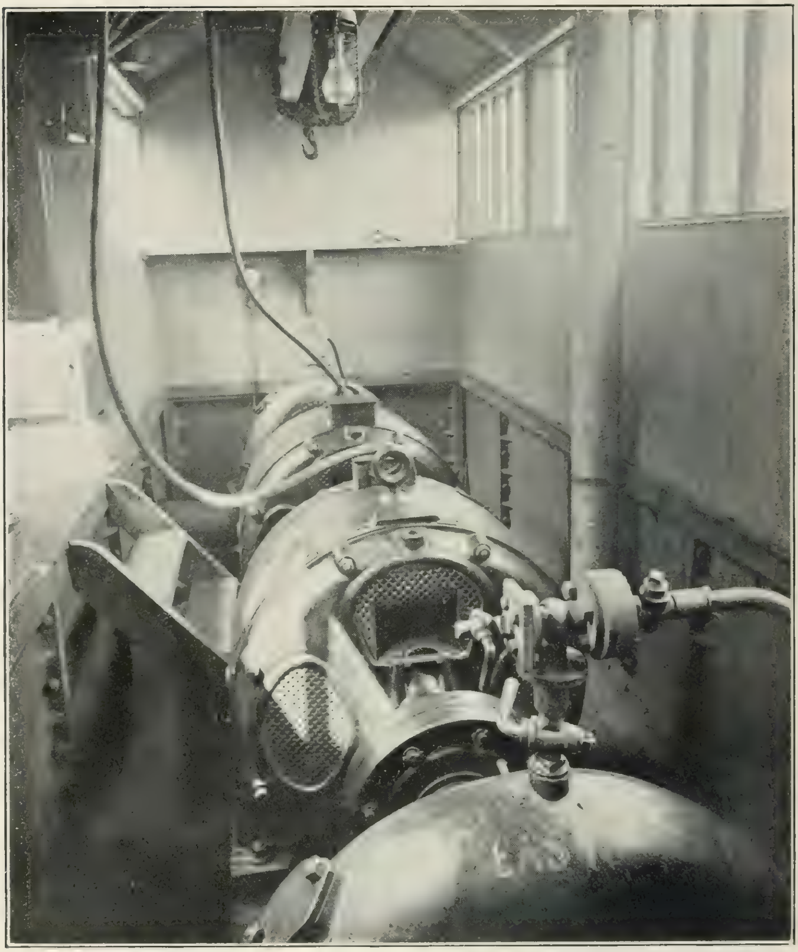
The starting arrangements are rather unique, and in my opinion calculated to get rid of some of the troublesome features attendant upon slip rings and switches for starting in dusty places. The supply current is led to a transformer box, upon the face of which is what Americans call a throw-over switch (Englishmen call it a two-way switch), arranged to handle the three-phase current. When in one position, a transformer is in circuit with the motor, which reduces the



ELECTRIC MOTORS OPERATING PUMPING PLANT FOR DRY-DOCK.
Newport News Ship-Building & Dry-Dock Company, Newport News, Va.



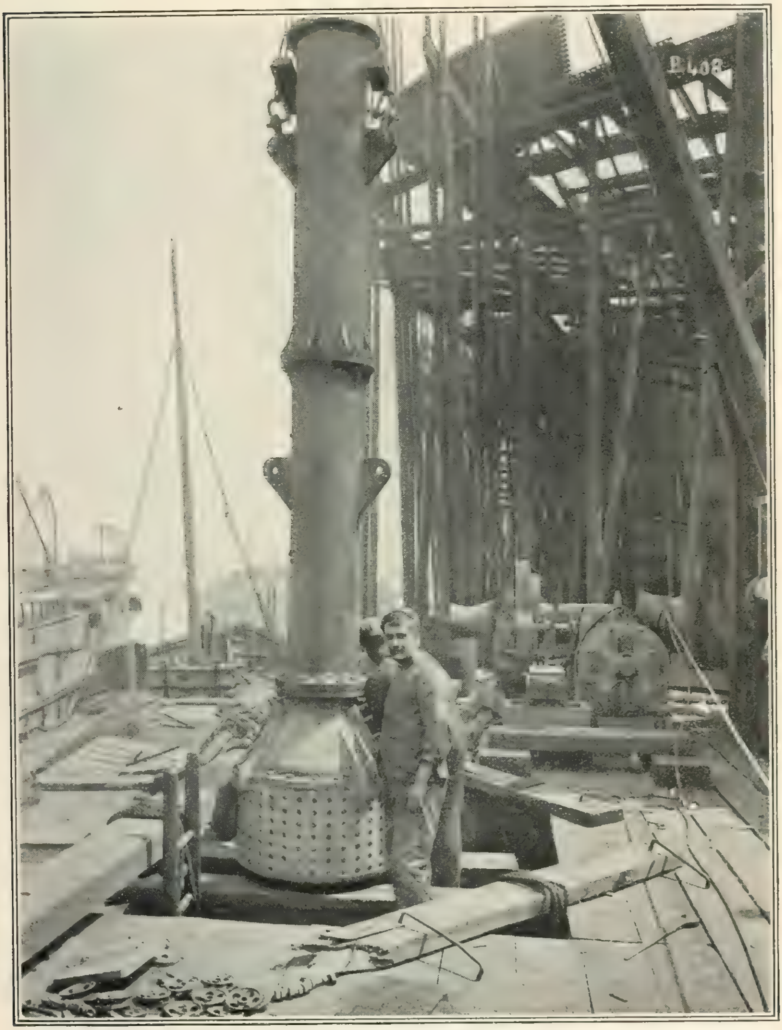
150-TON ELECTRIC REVOLVING CRANE, NEWPORT NEWS SHIP-BUILDING & DRY-DOCK COMPANY.



WESTINGHOUSE THREE-PHASE MOTORS DIRECT-COUPLED TO CENTRIFUGAL PUMPS, PALMER'S SHIP-YARDS.

pressure so that the starting current in the rotor is not excessive, and when in the other position the supply service is directly connected to the motor. The connections are made from the supply service to the autostarter, as it is called, and from the autostarter to the motor. To start, the workman has only to throw his switch over, and as soon as the motor has got up speed, to throw it back.

The arrangements at the switchboard are very complete. Each distributing board has a main entry switch and fuses, as well as the branch switches and amperemeters in all circuits. No break or joint is made in any cable. The periodicity is 30 cycles, and the motors

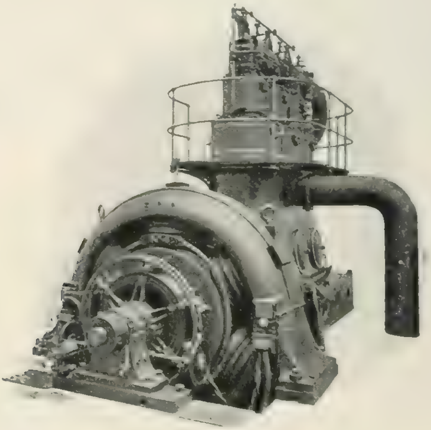


ELECTRIC DRIVEN WINCH, PALMER'S SHIP-BUILDING CO., JARROW-ON-TYNE.

Westinghouse three-phase motor direct-coupled. The winch is installed where needed and used in lifting portions of the work under construction.

range from 5 horse power up to 50 horse power. In this installation the lighting service is worked by a dynamo driven by a motor taking current from the power service.

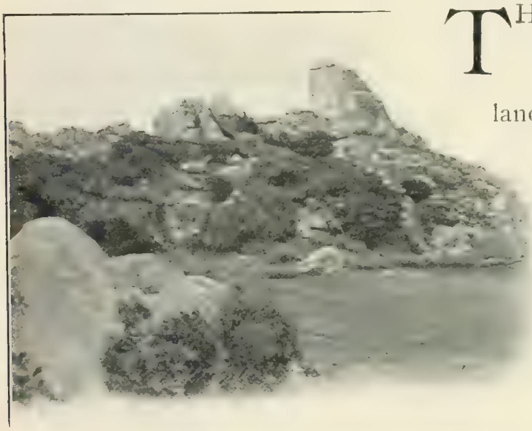
It may be interesting to compare this installation with one recently put in at the navy yard in New York. In this installation, the plant, which was also put up by the Westinghouse Company, though in this case of America, is of 1,200-kilowatts capacity, and consists of three two-phase alternators each of 400-kilowatts output, driven by cross-compound vertical condensing engines, running at 136 revolutions per minute. The boiler pressure is 160 pounds per square inch. The generators deliver two-phase currents at 220 volts and 25 cycles. The distributing cables are rubber and lead covered. The motors are all two-phase induction, and range from 200 horse power down to 5 horse power. In addition to one motor of 200 horse power which drives an air compressor, there are two of 100 horse power each. The cranes are fitted with direct-current motors, and to supply this, rotary converters are used, two of 75 kilowatts being installed. It will be seen that there are two differences between the English installation and the American, though in nearly every other feature they are exactly alike. In New York, motors up to 200 horse power are installed, while in Jarrow there is none above 50 horse power, and while in Jarrow the pressure of the service is 440 volts, that in New York is only 220 volts. There is the other difference, in New York the current is two-phase, while in Jarrow it is three-phase, but this is hardly a difference; it is merely a matter of taste, or one of those differences which run through all engineering. The other two differences, though, mark the trend of thought on the two sides of the Atlantic. American engineers are allowed to go faster in the matter of the quantity of power to be entrusted to an individual motor in work of this kind; but while American practice has been in so many cases to use high pressures, where English feeling his been against high pressures, it is very significant, that while in Britain we are prepared to go to higher pressures, on the American side, both in marine work and in mining work, the tendency is to lower the pressure.



THE RAILWAY REORGANISATION OF THE TRANSVAAL.

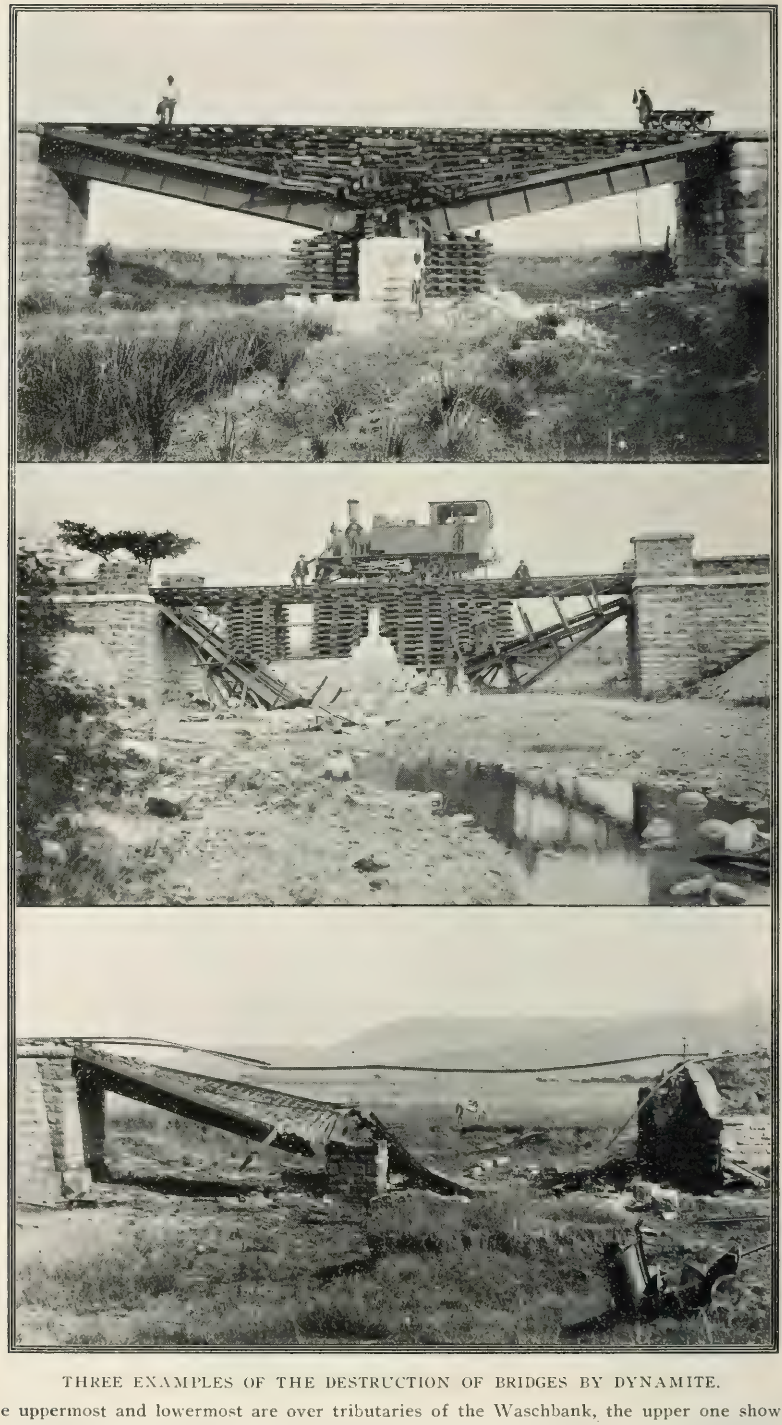
By A. Cooper Key.

With the return of peace and the restoration of order in the Transvaal, the reorganisation of the railway system and the regulation of traffic upon sound business principles become questions of the highest importance. Mr. Cooper-Key writes of his own intimate knowledge of past conditions upon the railways of South Africa and his judgment as to the policy to be pursued in the future is sure to attract interested attention.—The Editors.


A typical South African Kopje.

THE railway system of the Transvaal consists of the lines of the Netherlands South African Railway Company and the Pretoria-Pietersburg Railway Company. In addition to these is the Selati Railway (Komati Poort to Leysdorp) of which about 70 miles have been completed, but upon which no traffic has been carried. For all practical purposes, the Transvaal system may be taken as comprising simply the lines of the two administrations named above, at one time operating 717½ and 178 miles respectively.

A very important feature in connection with the South African Railway system is the policy to be pursued with regard to these two railways, and especially the Netherlands Railways. No need here to tell the history of that company, of its extortionate freight rates and passenger charges, how it fleeced the mining industry, how it increased the cost of all supplies. The administration of the Netherlands Railway as it existed in the past must be entirely changed. As a temporary measure the lines have been taken over by the Imperial military authorities. But what in the future when the country has settled down to civil administration?



THREE EXAMPLES OF THE DESTRUCTION OF BRIDGES BY DYNAMITE.

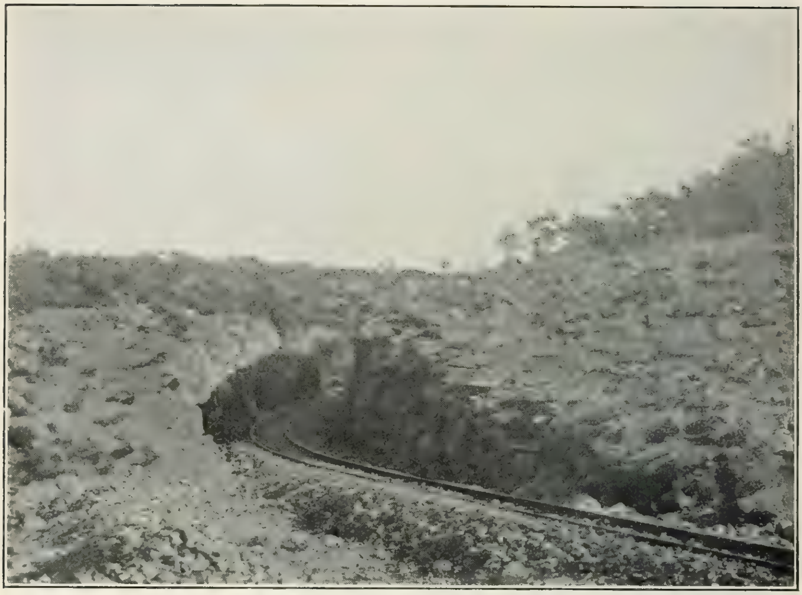
The uppermost and lowermost are over tributaries of the Waschbank, the upper one showing the method of repair adopted by the military engineers. The middle one is at Nelthorpe.

By courtesy of *De Ingenieur*.

KAFFIRS BOOKING AT PRETORIA.

For years before the war, the government of the late South African Republic had been urged, not only by the leaders of the mining industry, but by the more enlightened and patriotic section of the Raad, to expropriate the Netherlands Company. But as this was a step in progress and reform, the real rulers at Pretoria refused to carry out the scheme. It is true the matter of expropriation was frequently discussed, but still the monopoly remained. The purchase of the railway would have brought the country a large revenue and would have relieved the mining industry of what was undoubtedly its greatest burden. But like the dynamite monopoly, the railway was "a corner stone of the country's independence" in Mr. Krüger's estimation. The whole fabric of independence has collapsed, the corner stone is among the ruins. One word to indicate how outrageous were the company's charges, and how severely this affected the mines. The Industrial Commission which sat in 1897 advocated a gross reduction in rates amounting to £500,000 yearly. Undoubtedly this commission handled the company very tenderly. When, however, its report was considered by a Raad committee, all its recommendations were whittled down to such an extent as to be practically of no avail, and this latter body was of opinion a reduction of £200,000 would meet the just demand of the mines!

The Concessions Commission at Pretoria has been investigating the case of the Netherlands Railway. How hopelessly the company has compromised its position by the doings of its officers during the war



A SOUTH-AFRICAN RAILWAY CUTTING.
At Vygeboompoort, Pretoria-Pietersburg Line.

has been admitted by one of the principal administrators. Will the British government expropriate the concern? A policy of acquisition will no doubt prove the soundest.

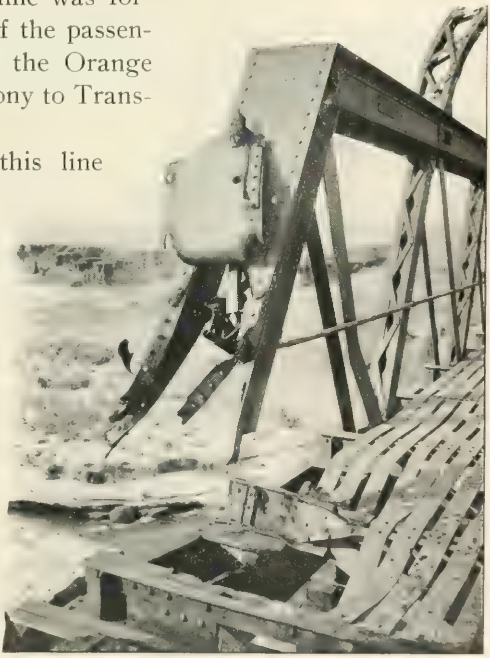
In South Africa government ownership of railways has been considered far preferable to private proprietory. Of course, the Netherlands administration has been the chief cause of the unpopularity of the latter system. Whether railway companies run equitably and on British lines would be satisfactory from a public standpoint is another matter. Even that seems questionable. It is virtually impracticable to have any competitive system of railways in the two new colonies. And without competition, would it be going too far to say that private control could never be altogether efficient and satisfactory? Why not fol-

NEW CARRIAGES AT PRETORIA STATION, READY FOR TRIAL TO PIENAAR'S RIVER, APRIL 27, 1899.

low the precedent of Cape Colony and Natal, in which colonies practically the whole of the railways are owned and worked by the government, to great and manifest advantage, both to the individual and the State?

Though in the present unsettled state of affairs one would hesitate to lay too much stress upon incidents, there appears to be some indication of a desire to fight the Netherlands Company on its own ground. Arrangements have been made to join the terminus of the railway system of the Orange River Colony at the River Vaal with an entirely independent line to Johannesburg, through the important though but little exploited coal field lying to the south-east of Krugersdorp. Indeed, the construction of the thirty-four miles of direct railway was one of the earliest works taken in hand after the British occupation of the Transvaal. This new line will supersede that of the Netherlands Company, which goes via Elandsfontein, forming there a junction with the lines to Pretoria and to the eastern extremity of the Rand. By this route the distance from the Vaal River to Johannesburg is no less than 51 miles. Upon the latter line was formerly conveyed the whole of the passenger and goods traffic from the Orange Free State and the Cape Colony to Transvaal stations.

By the completion of this line two distinct routes will be open from the Vaal to the Rand. For the western part of the Rand and Johannesburg, the new line will be the most direct, but for Pretoria and the East Rand the old line probably has a slight advantage in point of mileage, though this is set off by severe curves and gradients. The great bulk of traffic is of the "through" description, and the usefulness of these two lines (the old and the new) will be limited by the ca-



DETAIL OF THE FIRST ATTEMPT AT DESTRUCTION OF THE BRIDGE OVER THE WASCHBANK, SHOWING DAMAGE DONE BY DYNAMITE.

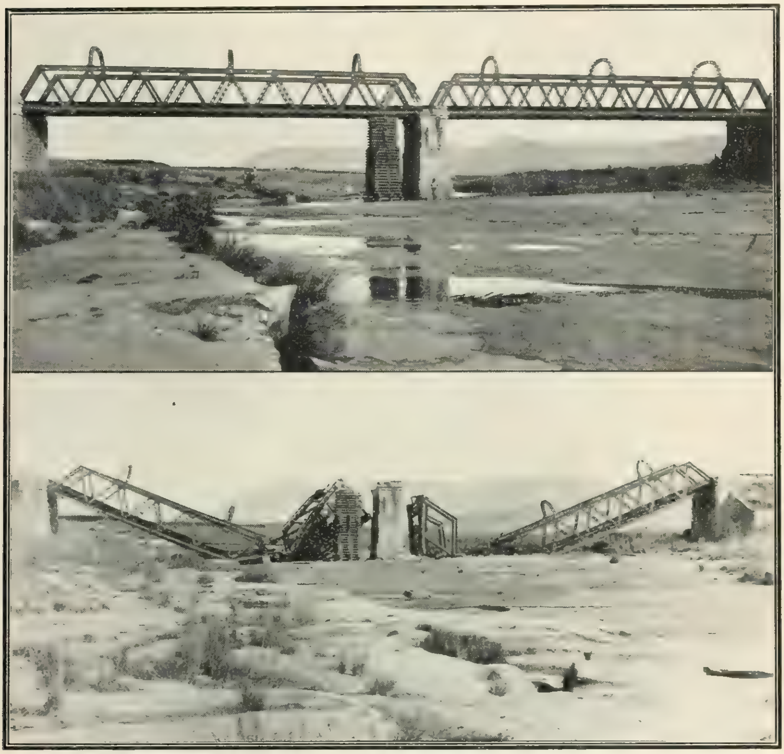
By courtesy of *De Ingenieur*.

PLATE-LAYER'S COTTAGE, HAMAN'S KRAAL, PRETORIA-PIETERSBURG RAILWAY.

pacity of the single line of railway through the Orange River Colony. There are, it is true, extensive coal mines at the Vaal River, the produce of which forms a heavy traffic. Hitherto this has all been carried southwards, chiefly for locomotive use on the Orange Free State and Cape Government Railways. Excessive rates have prevented these mines supplying the Rand, but even with reduced freight charges it is difficult to see how they could compete with such mines as the Clydesdale, the Great Eastern, and the Cassel at Springs in the East Rand district so much nearer the gold mines, and with the partly developed Sypherfontein mine, which the new railway passes, the nearest coal mine to Johannesburg and to the mines lying west thereof.

The old line could be used for the mineral traffic some expect from the Vaal River coal mines, and for traffic to Pretoria, leaving the new and direct line available for passenger traffic and through supplies to Johannesburg and the Western Rand.

With regard to the traffic from the South, there is no doubt the Netherlands Railway could be fought. More correctly speaking, there is little fighting to be done; the new line has assured the victory. There are, however, other matters to be considered. For instance, there is the



BRIDGE OVER THE WASCHBANK RIVER, AFTER FIRST AND FINAL ATTEMPTS TO DESTROY IT WITH DYNAMITE.

The second effort was after the retreat of the Boers behind the Biggarsberg Range. Reproduced by courtesy of *De Ingenieur*, of The Hague.

question of the traffic and the line to Delagoa Bay—Lourenço Marques —the nearest port to Johannesburg. The Portuguese port is only about 395 miles from Johannesburg, while the next nearest port is Durban, 483 miles, and the nearest colonial port, Port Elizabeth, 715 miles away. Although the facilities for handling cargo at Lourenço Marques are practically *nil*, large quantities of mining material and other supplies have in recent years come into the Transvaal by this route. Indeed, the traffic has been fostered by the Netherlands Company charging preferential rates to the detriment of the Cape and Natal routes. In large measure this has been justified, as the company had a haul of about 340 miles, compared with about 170 for traffic ex-Natal Government Railways, and only about 50 for that coming off the Cape and Orange Free State systems.

Given adequate facilities for discharge of cargo at Delagoa Bay, (or rather Lourenço Marques,) there is no reason why this port should

HAULING THE BOILER OF A 19-TON LOCOMOTIVE.
By courtesy of *De Ingenieur*, of The Hague.

not increase the hold it had upon the trade of the Transvaal. This opinion will be anything but palatable to those interested in the Natal and Colonial ports. And besides the advantage of geographical position—always an important factor in matters of this kind—regard must be had to political considerations. These two will in all probability prevent diversion of traffic—almost wholly "goods"—from Lourenço Marques to other ports.

It will be seen that the Pretoria-Delagoa Bay line is an important one. It would be in the last degree unsatisfactory to have it in hands foreign to the administration of other lines in the new colony. An alternative would be the construction of a new line from the Rand to Delagoa Bay, at at least an extension of the East Rand line from Springs towards Middelburg and so on to the seaboard. But this would mean the practical "paralleling" of the line from Middelburg to Delagoa Bay for a distance of from 150 to 200 miles.

Sentiment of course says "Never mind the foreign port, give all the trade of the new colonies to the British ports—Cape Town, Port Elizabeth, East London, and Durban." Put aside the question of the justice of this idea. Even if we allow its soundness, the acquisition of the Netherlands Railway appears advisable, if only to secure the 160 miles of track from Elsburg (a few miles south of Johannesburg) to the Natal frontier. To permit the Netherlands Company, as such, to remain would simply be sowing the seeds of endless complications. Naturally the company would not be content "to earn an honest penny"—we know enough of its past to be quite certain on that point. Where it could charge extortionately the opportunity would be seized. In the instance just mentioned, it would be unfair in the last degree for Natal traffic to be at the mercy of a company while the Cape Colonial ports were favoured with a State-owned route throughout. In such a case what would happen? The railway charges from the Cape Ports to the Transvaal and those from Port Natal to Johannesburg would be similar. The company if allowed to remain would grab the lion's share of the rate via Durban, leaving the Natal government lines with a modicum of profit. With that "half loaf" would they have to be content. Again, to leave the "reef-line"—the line along the mines from Boksburg to Krugersdorp—in the hands of a private concern of the type of the Netherlands Company would be a policy leading to endless friction. An entirely new line paralleling the old one would not altogether circumvent the difficulty.

DESTROYED BRIDGE OVER THE TUGELA RIVER AT COLENSO.
By courtesy of *De Ingenieur.*

It may be argued, has in fact been argued in certain quarters, that the actions of the railway officials during the war, and more especially the acts of destruction of railway bridges and plant in Natal and elsewhere, make the discussion of the question of expropriation a work of supererogation. Instead of "buying out"—"expropriation"—it is a matter of "seizure." Admittedly there is a great deal to be said in support of this view of somewhat drastic procedure. But would it be consonant with British ideas of justice and fair-play? For the members of the Hollander gang which blew up bridges in Cape Colony and

Natal in the rear of the retreating Federal forces no punishment is too severe. And such punishment must be meted out. But the punishment for their misdoings cannot be extended to innocent European shareholders and bondholders.

No just or valid objection could be made against the buying up of the Netherlands South African system at bed-rock prices. Whatever share the late government had in the railway must be reckoned spoil of war, and for such no payment would of course be made. Then again should be further deducted the value of the holdings of officials and others (chiefly Hollanders) who broke their neutrality.

Excluding the shares held by the government of the South African Republic, it may be stated that reckoning the outside shares as being paid off at par and the debentures at a premium of 10—the bonds bear 4 per cent. interest at the rates of 4.8 per cent. and 5 per cent. on different issues—the acquisition of the lines, rolling stock, plant, etc., could be effected for about £7,500,000. This works out at rather over £10,000 a mile including equipment—not an extravagant figure. It cannot be reasonably urged that the British government should take cognizance of, much less adhere to, the clauses in the original contract between the government of the late South African Republic and the railway company relating to expropriation. *Inter alia,* this provided that the shareholders should receive twenty times the average dividend of the three preceding years. As the company earned 13¼ per cent. on its capital in 1896, 12¾ per cent. in 1897, and 11½ per cent. in 1898, this form of valuation is entirely out of the question. The British government always deals fairly, can it be expected to deal tenderly with the proprietors of an organisation which has greatly assisted the Republican forces against her, though it was a Dutch concern with its head offices at Amsterdam?

During the last three normal years the Netherlands Railway made profits approaching £1,400,000 annually. If backed by Imperial guarantee there should not be the least difficulty, even in these days of dear money, in raising a railway loan of say £8,000,000 bearing interest at 4 per cent. For the service of this loan the sum of £320,000 would be required each year. A satisfactory sinking fund would be provided by setting aside £250,000 annually for debenture redemption. There would be still a large margin between these two items and the profit figures of the past. Rates and fees could be reduced by quite 50 per cent. with proper and up-to-date management. Moreover, even on that basis of reduction substantial sums could be provided for betterment of lines and stations and renewals of engine and coaching stock.

THE NUMERICAL RECORDING OF SHIPPING AND MANUFACTURING ORDERS.

By Kenneth Falconer.

THE CARD INDEX SYSTEM IN SHOP ADMINISTRATION.

The filing of letters, orders, and other commercial documents is a matter which should interest not only the office management, but also the works manager, especially with the introduction of modern methods of workshop accounting and cost-keeping in which each piece of work is made the subject of a separate record as it passes through the works. Mr. Falconer describes a system which has been found to possess many advantages in practice, and which should meet with the interested attention of managers and workshop accountants very generally.—THE EDITORS.

ANY system for handling and recording shipping and manufacturing* orders, in addition to such requirements as are necessitated by special circumstances, should accomplish the following general objects:

The plan adopted should guard against the possible loss of an order after receipt at the order desk, or any unnecessary delay in transmission to the department interested; against the likelihood of neglect or oversight by the shipping department in the case of a shipping order, or by the factory office in the case of a manufacturing order; and against the risk of goods being manufactured and received from shops without advice as to what shipping order they are meant to fill, and so put into stock instead of promptly shipped. It should eliminate entirely the possibility of goods manufactured to fill a certain shipping order being shipped or delivered without proper charge therefore being made. In addition the system should enable those interested to refer without delay to the original authority, signed by the customer, upon which any shipping or manufacturing order has been issued, and to ascertain what portion, if any, of the goods called for has been manufactured or shipped and what balance remains uncompleted.

Completed orders should be filed in such way as to be readily obtainable, whether asked for by the name of the article manufactured or of the customer for whom they were made, and to minimize the chances of being replaced in a wrong position after being referred to. Their arrangement should be such that all orders, whether the original received from customer or the shipping or manufacturing order issued from the order department, shall always be found in the same relative position one to another, and that comparisons with the previous manufacture or sale of similar goods, as regards cost, selling price, and profit, may be easily made, and any abnormal difference promptly seen and looked into.

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* Shipping orders—written instructions from the order to the shipping department to ship or deliver certain goods to a named party. Manufacturing Orders—written instructions from the order department to the factory office to have certain articles manufactured, or specified work done.

Finally, these risks must be guarded against, and requirements met with the least possible expenditure of time and labor consistent with the results looked for, and the work so distributed that practically all the clerical part shall be done in the office.

To obtain these ends with a minimum of error and a maximum of efficiency, the numerical system of handling and filing may be used to the greatest advantage. It provides for each point and safeguard equally as well as the alphabetical, and at a less expenditure of time, while for convenience in filing and referring to orders and papers, a comparison is very strongly in its favor. For example; one knows instinctively the correct relative numerical positions of three cards numbered 25, 26 and 27—where to file them or to look for them, as the case may be. If instead of numbers the name is to determine their relative positions, and they are headed respectively:—The Robinson Tool Co., Thos. Robinson & Co., and T. J. Robinson—their correct alphabetical arrangement is not so easily and readily determined. In other words, when the numerical system of filing is in use the factor which decides the position of any card or paper (i. e., the number) always indicates exactly such position. With the alphabetical system, the determining factor (the name) only approximately indicates the correct position, and even this may be largely affected by peculiarities of spelling indulged in by the writer of the name. Supposing the name unfamiliar and the sound the only guide; papers referring to Chas. Magee might be written and filed or looked for under McGee, Macgee, or Magee. If, however, Chas. Magee is represented by, say, number 126, there is little likelihood of any paper bearing such number being placed in a wrong position. The numerical system once adopted, numbers become as familiar as names, and are quite as easily remembered.

The base of the system here described is a conversion of names into their corresponding numbers at the order desk, and thereafter their arrangement and classification according to such numbers.

To accomplish this, the order clerk is provided with a number register and a card index. The former is a book of size to accommodate the quantity of names likely to be given a number; the latter is a card index, with alphabetical guides, large enough to receive a card for each name entered in the register. Perforated cards with a locked rod should be used. When a number is allotted to any name, a card is made out bearing that number and giving the full name and address of the person or firm to whom it has been allotted, which has previously been entered in the number register. This card, which is placed in its alphabetical position in the index, should also bear any special instructions regarding shipments or invoices for such customer. To provide for orders from customers who may probably not give more than the one order, the first twenty-six numbers, one for each letter of the alphabet, are reserved for sundries. Should it be found advisable later to allot a number for the name of any customer whose previous orders have been filed under any one of these "sundries" numbers, such past orders may be renumbered, or the card issued may bear a memorandum, "Before this date see Sundries No.————."

The value of this card index may be greatly increased by careful cross-indexing—i. e., where orders from the same concern are signed by different persons by placing in it a card for each name so used, bearing, of course, the number of the firm or company for which they sign, and which is looked to for payment. After a very short time, except to issue a new number, this book and index will be hardly referred to more frequently than the directory is used to ascertain a customer's initials or address, where the alphabetical system is in use.

To operate the system properly and thoroughly, in addition to the above book and index, the following cabinets are required, as well as the necessary forms and cards:

A filing cabinet, indexed numerically from one up to whatever number a careful estimate shows is likely to be required. This cabinet receives the original authority upon which each shipping order is based, and retains it until the entire order has been filled.

A number of box files indexed in the same way, to which letters, telegrams, etcetera, are transferred from the filing cabinet on completion of the order.

A card-index cabinet large enough to contain a card for each manufacturing order issued during a year, and in addition one reserve drawer for cards representing orders in process of manufacture.

Lastly, a vertical filing cabinet large enough to contain a shipping slip for each part or complete shipment made during a year, and in other drawers the cost sheets bearing a detailed statement of the cost of each manufacturing order issued during the same period—these, of course, all with the necessary guide and index cards and folders.

The outlay involved may make the expense of the plan seem great, but it must be remembered that these cabinets represent a first expense only, not an annual one. Cardboard transfer cases of the same size as the various drawers, are obtainable at a nominal cost, and each year's records are transferred to such transfer cases, the cabinets being used for the current year's work only.

The filing cabinet for the letters, etc., upon which shipping orders are based is kept in most convenient reach of the order clerk and also of the invoice clerk. To obtain the best results, a shipping order must not be issued under any circumstances without a written authority for such order being filed in this cabinet. In cases where mail matter may contain nothing requiring the attention of any but the order department, it is handed at once to the order clerk after being initialed by the proper authority. If, however, it requires the attention of any other official or department, an extract of the part containing an order is made by the stenographer, and a shipping-order number obtained from the order desk and noted on both the letter and the extract. Letters and post cards advising the return of goods are treated in the same way. For orders received from travelers, either of two plans may be adopted:—the traveler may send in his orders on a regular shipping-order form, in duplicate, and the copy may be filed in the cabinet; or the order may be received by the house on an ordinary traveler's order form or sheet, which after being re-written on a regular shipping order is filed in the cabinet. The latter plan, while giving some additional work in the office, leaves the traveler more freedom to write full particulars regarding his orders than is permitted if he has to make them out on a set form. Orders given in person or received over the telephone should be written out on a memorandum form before the shipping order is made out, and where possible the purchaser should sign the memorandum. In any event, it should contain full particulars as to by whom it was given and received, and any promised or understood date of shipment.

On receipt of orders, whether telegraphic, mail, or memorandum, the order clerk first marks prominently on each the file number of the person or firm the order is for. These numbers he can obtain by referring to the card index above spoken of, though he will very soon do most, if not all, from memory. (Any one who doubts this statement should ask the time clerk of any large factory if he finds difficulty remembering the numbers representing the names of employees). As soon as the file number is marked, a shipping order is made out and entered in the shipping-order register, being given the first blank number, which preceded by the letter "S," (shipping), is also marked on the letter, telegram, or memorandum, as the case may be. Such orders as may require it are then acknowledged by a printed post card, which also requests that any inquiry regarding the goods ordered should refer to the following numbers F———— S————. In these spaces is filled in the file number representing the customer's name, and also the shipping number given that particular order. The letters and memorandums are then filed in the order clerk's cabinet under the index sheet bearing their respective numbers. It will be seen that should a customer make inquiry regarding any order, this inquiry will bear on its face information as to the exact location of the original of the order referred to.

Each day the shipping clerk returns to the order clerk the shipping orders on which he has made a part or complete shipment. These shipments are priced by the order clerk, who issues a new shipping order bearing the same number and date for such items as have not been sent forward, prefixing "B. S." (back shipping) to the order number. Such items as have been shipped are then billed to the customer in the usual way, each entry being numbered consecutively. This number is noted both on the invoice and on the letter or other written instructions upon the authority of which the shipping order was first issued, part shipments being so marked. Letters, etc., representing orders upon which complete or final shipment has yet to be made are returned to the cabinet, while those representing completed orders are filed away in box files indexed on similar lines.

The shipping orders on which any shipment has been made have now become shipping slips. The invoice number they bear is noted in the shipping-order register, which is ruled in such way that a certain column is reserved for the entry number of final or complete shipments, those of part shipments being entered in other space. By this means a periodical examination of the shipping-order register will show at a glance what orders are in possession of the shipping department upon which no shipment or part shipment only has been made, and the date such orders were received. Without leaving the office the management can see how shipments are being got out.

During the current month these shipping slips are arranged according to invoice number. At its close a statement of their totals is taken off, showing cost and selling price of each shipment distributed among the various departments. The aggregate of the selling value will, of course, equal the total of the day book. When this is done the shipping slips are filed away in a vertical filing cabinet, arranged numerically by file number, and those for each customer according to invoice number.

A manila folder of which the inner sheet projects about half an inch above the outer is used for the charge-slips against each customer. On this space is written the customer's name and file number. As slips are inserted in these folders from month to month, it will be found that some customers may require a new folder each month, while for others one folder will take the full year's charges. Where two or more folders are required during the year for the same customers each should be marked with the months in which were made the entries for the slips therein.

In the question of manufacturing orders, more perhaps than in any other branch of office work, is this the day of cards and loose sheets instead of books. By keeping records of such orders on sheets and making out an index card for each order, a most complete system of indexing and filing may be secured with the use of the numerical system.

The foundation of the system is the entering of the number of each manufacturing order issued in the shipping-order register, opposite the shipping number of the order calling for the goods, and in each cost sheet and card for such manufacturing orders, bearing, besides the customer's name, the file number representing such name and also the manufacturing order number. Until the order is completed the cost sheets are kept arranged by the number of the manufacturing order—this for convenience in entering charges against them. The cards are filed in a card-index cabinet, arranged according to the number representing the name of the customer. The file number being known, reference to this index will show all orders in process of manufacture for any customer. Part deliveries from shops to stock room being noted on the cards, it will be at once seen what balance remains for the factory to supply. As these cards bear the number of the manufacturing order which they represent, reference to the corresponding cost sheet will show at once the progress or cost of such order to date.

Articles delivered from shops to shipping or stock room are accompanied by a card bearing the file and manufacturing-order number, the date, and the quantity and name of article. These cards, after being initialed by the stock-keeper, go to the office where the quantity is noted on the card representing the order. They are then handed to the invoice clerk, who retains them until he receives a shipping slip, and makes a charge for the articles thereon. This being done, he notes the entry number on them and they are filed away. It will be seen that the only cards in his possession should be those representing articles delivered from shops to stock room for a certain customer and not shipped. Failing to receive a shipping slip for the goods within a reasonable time, inquiry is made, the cause of delay ascertained, and the error or omission to charge rectified. After completion of any order, the cost is noted on the card representing that order and they are then filed according to article or class of goods. The cost sheets are filed in a vertical filing cabinet, on exactly the same lines as the shipping slips, thus being self indexing.

At the end of any given period the cost sheets, showing the details of all orders for each customer, are together, and the card records of the same will be found classified according to goods.

If this system in all its details is carefully and completely carried out, the management will have constantly at hand full information as to all orders, from the time they are received at the order desk until complete shipment has been made and billed to the customer. The point aimed at is to arrange all cards and papers as far as possible so that, the customer's file number being known, they will be self-indexing, and in addition to this, to have each card or paper indicate, in addition to the information contained thereon, where to look for more details, or for further disposition of the matter. Thus a reference to a certain number in the shipping-order register will show what shipments have been made, and the number of the day-book entry for such shipments. It will also show the number of the manufacturing order (if any), on which the goods are being, or have been, made in the shops. Reference to the card for the manufacturing order will show what (if any) part-deliveries from shop have been made, and the receipt for such deliveries signed by stock keeper will be found with the card representing the order, and will show the number of the day-book entry charging the goods to the customer. If further information is required, the card gives the number of the cost sheet on which full particulars of the cost and work to date will be found.

As regards completed orders, the shipping slips give particulars as to the cost and selling price of each shipment. If desired, a statement may be made out each month and a similar one at the close of the year, showing the profit on sales of each department, or on sales to each State or town, or even customer, the aggregate agreeing, of course, with the total profit on sales as shown by the sales accounts.

All shipping slips for the same customer during a year being together, such slips when transferred at the close of the year to a transfer case, become practically a copy of the day book with all charges against a given customer in rotation. In looking up an entry for a given article known to have been charged a certain customer, this will be of great value. Advantage will also be found in having all orders received from customers filed separately from other correspondence. Completed manufacturing orders may be promptly referred to, whether asked for by number of order, name of article, or name of customer. The cards showing cost of the manufacture of the same article at different times will be found all together, thus practically forcing comparison.

I have treated here only the question of manufacturing for customers' orders. The indexing, handling, and recording of orders for the manufacture of goods for stock may also be most advantageously done with cards and loose sheets.

The plan here described is largely the result of study along lines suggested by one who ranks high as an authority on shop practice and management. In a personal letter he said "in these days of the card index, one should have a full comprehension of the possibilities of that index in all parts of the administration department of a machine shop.

THE BRIQUETTING OF FUELS AND FINE MINERAL ORES.

By Wm. Gilbert Irwin.

The utilisation of waste products in various lines of work has furnished many fruitful fields for the work of the engineer. In industrial health, as in bodily health, however, prevention is better than cure, and everything which tends to prevent the occurrence of waste may be considered as a direct contribution to national wealth.

Mr. Irwin shows how the introduction of modern briquetting machinery prevents waste, not only in connection with fuel, but also in various lines of metallurgical industry, to the manifest advantage of both product and methods.—THE EDITORS.

IT has been within a comparatively recent period only that American manufacturers have been giving any definite attention to those numerous lesser economies which for a long time have been the subject of careful study on the part of the learned scientists of Europe, and have long been exploited by many European manufacturers; but during the last few years remarkable progress along these lines has been made in the United States. The extravagant abundance of all kinds of raw materials has been largely responsible for the neglect which prevailed until within the last half-dozen years or so, and while there is as yet no diminution of the raw materials in sight, American manufacturers have come to realize that the greatest economies really lie in getting the most workable materials from the smallest body of raw material—or, in other words, in producing a maximum of output with a minimum of effort. These ideas have long prevailed in the countries of continental Europe, having been impelled from the conditions existing there. The ore, fuel, and other raw-material supply of those countries has long been limited, hence the necessity for the strictest economy along all lines.

For a long time the great universities of continental Europe have displayed a keen interest in matters of social and industrial economy, and in consequence the manufacturers of those countries have greatly benefited from such studies and researches. However, great as has been the progress of some of the countries of Europe along strictly scientific lines, made possible through the great institutions of learning built up during many centuries, the more inventive mind of the American scientist has readily absorbed the result of all this progress, and within a few years has made many new departures based upon the researches and ideas evolved in the Old World. A striking instance of this is to be seen in the briquetting industry. For many years the briquetting of mineral fuels has been carried on extensively in Europe, and the first attempts at briquetting made in America were confined to similar lines. However, it was not long until the idea of applying the same process to other minerals was evolved, and as a result the briquetting of fine mineral ores has, through the experiments of the past six or eight years, come to be an important feature of metallurgical practice.

While the briquetting industry as carried on in continental Europe and in England is still almost wholly applied to the briquetting of mineral fuels, three distinct fields for this important economic industry have already been exploited in the United States, i. e., the briquetting of coal and coal dusts, lignite, and other forms of mineral fuel, along which lines the industry was first exploited in Europe; the briquetting of fine ores and flue dusts; and the briquetting of precious mineral ores. The application of briquetting to other than mineral fuels, as has already been intimated, is strictly an American idea, evolved through necessities arising from the operation of modern precious-mineral smelters, and to meet certain conditions arising from the advanced departures in iron-furnace operations.

Before entering upon a discussion of the scientific application of the briquetting industry to these new requirements, it will be well to trace the progress of the idea as originally applied to the fuel industry, along which lines the briquetting industry is destined to undergo a wonderful development in America at no distant day. The idea of compressed fuels can be traced back to the year 1594, when Sir Hugh Pratt wrote a pamphlet upon the subject; but it was not until the year 1842 (when the mechanical manufacture of fuel briquettes on a commercial scale was begun at Berard, near St. Etienne, France, from which country the industry was introduced into other countries of the Continent and into England) that briquetting in the modern sense of the word, received its first exploitation; and from that time down to the present day the progress of the industry has largely been marked by the evolution of briquetting machinery. The early ideas involved the single-compression press, such as the Mazeline, Stevens, Crozot, Exeter, Revollier, Dupuy, Matin and similar presses. A tangential machine for the manufacture of ovoid balls of fuel for domestic and other use was also evolved and had a wide use in continental Europe. Then came the double-compressing machines in which the briquette is formed against the back of another. Of this type may be mentioned the Evrard and Bourriez presses. Another type of press evolved in

Europe was the roller press acting tangentially to which type belong the Loiseau, Gilly, Maison de Beer, Zimmerman, and Fouquemberg machines.

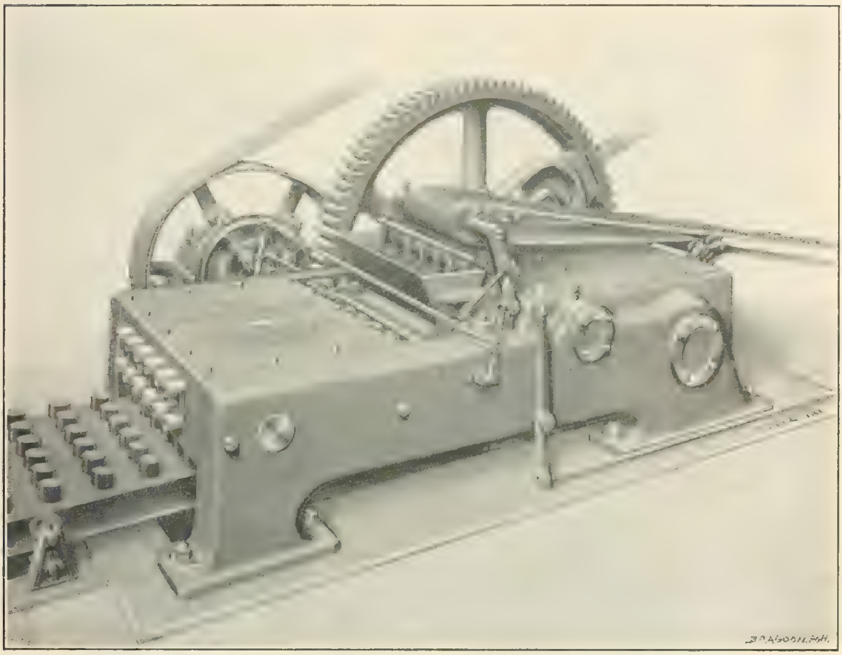
After the success of the idea had been demonstrated through the operations at Berard, numerous other plants were installed on the Continent and in England. Among these may be mentioned the plant of the Paris, Lyons and Mediterranean Railway at La Chazotte employing the melted pitch process, which process was also used in the early attempts at fuel briquetting in the United States. The Parrache Gas Works at Lyons also operates a briquetting plant and uses the Dupuy horizontal press. The Jacoby-Louvre press is largely used in the Halle district of Prussia, while at Castelnuovo in Italy a modern briquetting plant has just been installed for the manufacture of fuel briquettes from lignite, which feature of the industry is now an important one in various European countries. The Paris Gas Company for some years manufactured briquettes from coke refuse, and this is also being done at other points in Europe. A pioneer plant in the dry-pitch method of briquetting was that installed at Newport in Monmouthshire, England. In this process, as in the wet-pitch process, the pitch is broken in a pug mill and then added to the fine coal dust, the mixture being heated in order to render it pasty and cause a cohesion. In experiments conducted abroad various binding materials such as pitch, tar, farina, starch, dextrine, clay, sawdust, plaster of Paris, lime, chalk, magnesia, sulphur, paper-pulp, nitrate of potash and silicate of soda have been used. In tracing the development of the fuel briquetting industry in America further mention of these will be made. The cost of fuel briquettes per ton in England averages 9s. 7.45d. ($2.32) and in France 13s. 0.96d. ($3.14) while the cost in other European countries varies but little from these figures.

While no definite effort looking to the systematic utilization of waste anthracite and bituminous coal was made in the United States until 1868, patents bearing upon the subject were allowed by the United States patent office as early as 1837, and since that time more than a hundred bearing directly and indirectly upon briquetting have been issued. For a long time the foreign systems were closely followed by the American exponents of briquetting for the utilization of fuel waste, but more recently efforts along these lines have taken a new departure and briquetting machinery of a strictly American type, evolved with special reference to the requirements of the waste fuels of the country, is to be employed in turning the waste mineral fuel into the uses of modern industry.

The first attempt to install a mechanical briquetting plant in America was made at Port Richmond, Philadelphia, in June, 1868, when a plant of the Loiseau system, the invention of E. F. Loiseau, a Frenchman, was begun for the briquetting of anthracite culm; but it was not until some years later that this plant was finally completed and put into operation. The manufacture of compressed fuel was begun at Rondout on the Hudson by the Delaware and Hudson Canal Company in 1876, 92 per cent. of anthracite culm and 8 per cent. of pitch being used. This plant was sold to the Anthracite Fuel Company the same year and its operation was discontinued in 1880. The Port Richmond plant was also abandoned after having been operated for a few years. Before this time an attempt to manufacture briquettes from anthracite culm at Mauch Chunk proved a failure. In 1890 the Anthracite Compressed Fuel Company was formed, and a briquetting plant was installed by the company at Mahanoy City in Schuylkill County, Pennsylvania. The plant was operated for about two years and was finally abandoned in 1895. Similar plants were also installed at Gayton (Virginia), Milwaukee (Wisconsin), Huntingdon (Arkansas), and at Chicago. In all of these plants the manufacture of small briquettes, known as "eggettes," was conducted in accordance with the ideas evolved in Europe where this type of machinery was first used.

While these early attempts at briquetting resulted in no permanent establishment of the industry, some valuable experience was gained. The operations in the anthracite-coal fields of Pennsylvania demonstrated that briquettes can be manufactured from anthracite, using coal-tar pitch as a binder, at a cost of $1.80 per ton. In these early operations bituminous slack coal and lignite were also briquetted with some success. It was also shown that pitch and vegetable compounds are best suited for binding for fuel briquettes. Pitch adds a great amount of smoke, and it is quite probable that in future operations the vegetable bindings, such as farina, dextine, and starch, will come into wide use for purposes of binding. Lime, which is largely used in briquetting fine minerals, has been found to add considerably to the ash when used in fuel briquettes, hence its use in this line of briquetting will necessarily have to be abandoned.

In preparing coal for briquetting it has been found best to put it through a series of washing or "jigging" processes in order to reduce the percentage of ash and sulphur. Special apparatus has been evolved to measure the cohesion, and the calorific power of the fine coal thus prepared is slightly, if at all, lower than that of unbroken coal. To



WHITE BRIQUETTING PRESS.

Capacity 100 tons every 10 hours.

sum up the knowledge of fuel briquetting obtained through these early attempts at briquetting in the United States, it may be said that it was found that this artificial-fuel product must be homogeneous and hard so as not to break in transportation, its combustion must be as near smokeless as possible, it must be of a convenient size and shape, must not be hygroscopic, must not contain more than 5 per cent. of moisture, must leave a minimum of ash, must be easy to kindle, and must burn freely.

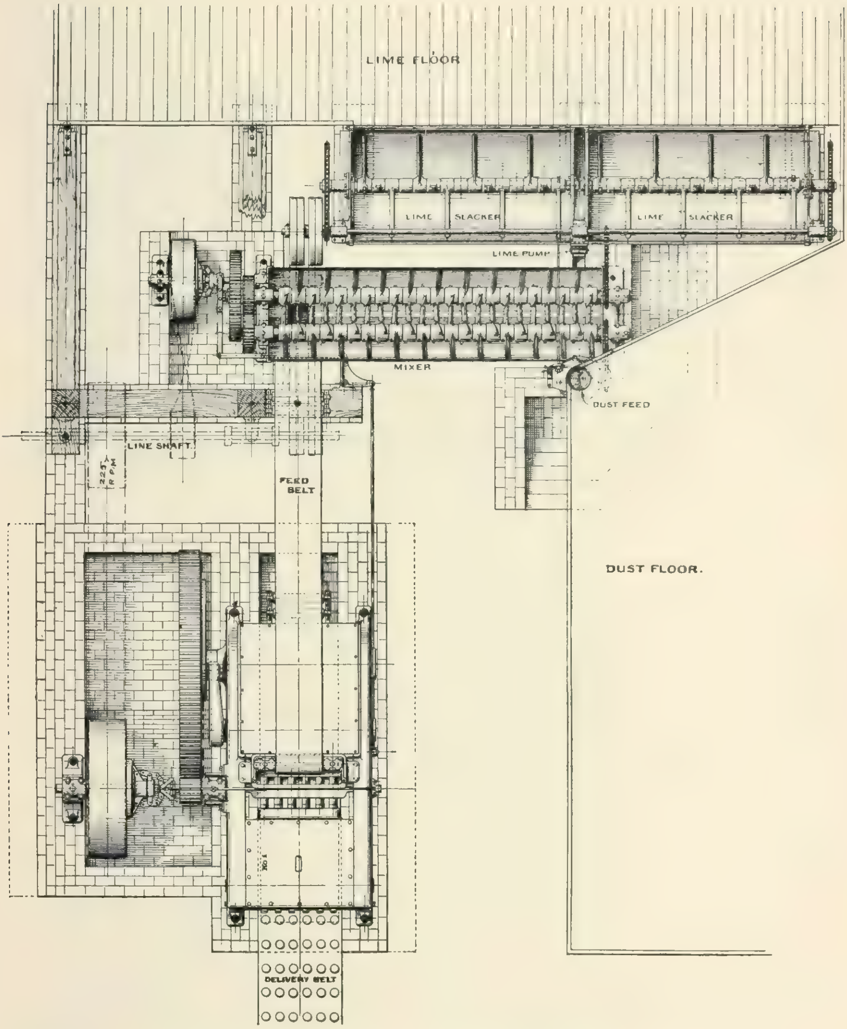
With the knowledge thus gained, supplemented by the results of recent work along the same lines to draw from, the capitalists who are in the future to turn the millions of tons of slack and worthless anthracite and bituminous waste, and the lignite and brown coals, to the uses of modern industry through the briquetting industry can now conduct the work with some degree of certainty. During the past few years the progress of the briquetting industry has largely been a record of the evolution of briquetting machinery; hence the necessity of here devoting some space to the progress of briquetting presses.

Some six or seven years ago a smelting company in the western

States purchased a Boyd brick press and began a series of experiments in briquetting flue dust, fine ores, concentrates, and other non-elastic materials. While the press was perfectly adapted to brick making, it proved a failure when applied to a use for which it was never intended. However, from the attempt was evolved the idea of constructing a press for the briquetting of fine minerals and for some time Mr. B. C. White, one of the early advocates of briquetting in America, devoted his efforts to adapting a brick press to the purposes of mineral briquetting. The result was an elimination of the grinding pans, mixers, elevators, spouts, and press used for brick making, and the invention of a combined mixing and briquetting press, known as the White mineral press, which was perfected in 1896. Although this machine supplied a long felt want in the way of briquetting presses, it underwent decided improvements soon after it was placed on the market. As the result of further study along this line combined with a thorough examination of the briquetting systems of England and continental Europe, the White briquetting press of 1899 was perfected and put into quite extensive use, its operation proving entirely successful. The complication of such machinery was further eliminated in the White briquetting press of 1901, which machine was brought to a high state of perfection through improvements made since.

The White briquetting press is made in three sizes, Nos. 1, 2 and 3. The No. 1 press has a capacity of 100 tons per ten hours in briquetting precious metal ores or iron flue dusts, while Nos. 2 and 3 are adapted to briquetting on a less extensive scale.

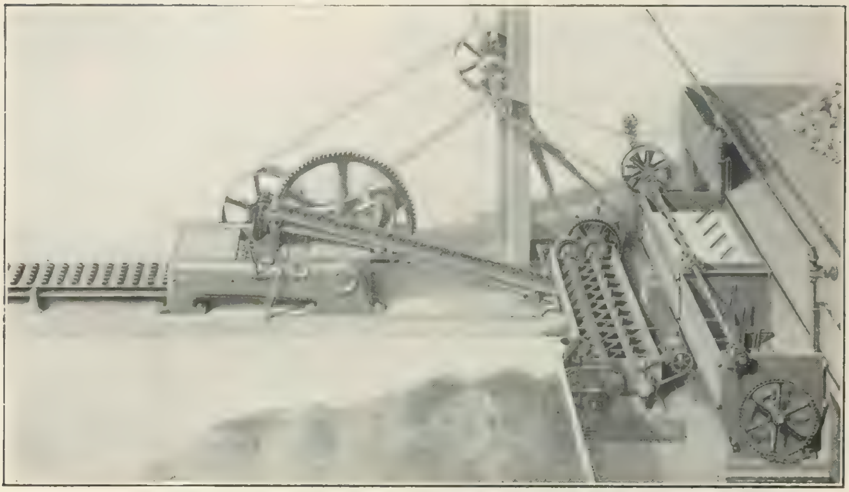
This machine, through a system of interchangeable pockets and plungers, is applicable to various requirements of mineral and fuel briquetting and today the system is in use by many mining companies in various parts of the United States and other countries. A model experimental plant has lately been put into operation in Pittsburg, a description of which will adequately convey the mechanical operations involved. In mineral briquetting a lime binder is used, while pitch or vegetable binding material is used in fuel briquetting. The slackers, two in number, which prepare the binding material, communicate by large openings at the bottom of the hollow middle casting and operate alternately, so that while the binding material is being slacked in one the pump will be drawing the prepared binding material from the other, a cut-off valve which opens or closes either of the openings being operated from above. The openings are screened to prevent lumps from getting into the pump. The slackers are driven



GENERAL ARRANGEMENT OF WHITE BRIQUETTING PLANT.

Showing lime slacker and mixer, and delivery of material to and from press.

independently by tight-and-loose pulleys, belt shifters which are operated from the floor above the slackers being supplied. The binding pump is driven by a chain from one of the mixer shafts, its stroke being regulated by a rod and hand wheel mounted on the dust feed, by which the amount of binding may be accurately adjusted. The materials to be briquetted are conducted into an automatic dust feed through an opening in the dust floor through an automatic arrange-



WHITE BRIQUETTING PRESS AND OUTFIT.

ment, the feed being driven by a chain from one of the mixer shafts. The materials to be briquetted are fed automatically into the press, which is provided with a friction clutch pulley driven from a pulley on the line shaft, the clutch being automatically operated. The man in charge of the press has also control of the whole machinery of the plant. At this experimental plant all kinds of minerals and fuels are being briquetted with a view to the further development of machinery along this line, and in order to adapt the machinery to the varied requirements of the industry.

Another exponent of the coal briquetting industry in the United States manufactures the Belgium Mineral Press. This machine in connection with the Gardner Corning fuel briquetting patents is used at the plant of the Briquette Coal Co., of Chicago. Through the use of a patent binding material, briquettes manufactured by the Corning process are almost smokeless and they possess superior qualities of toughness and density, retaining their form long after they have become incandescent and reduced to a white ash.

In this system the coal is reduced to a pulp by being passed through powerful crushers before the binding material has been added. The mass is then carried to a furnace where a temperature of from 180° to 200° F. is maintained, and is thus heated sufficiently to make the binding material adhere firmly and to produce the desired results without in any way changing the chemical composition of the coal dust. It is then conducted by an automatic elevator to the floor above, where it is mixed with the binding material while it is still warm. It is now ready for the press which subjects it to a pressure of about five tons to the square inch and when the briquettes drop out of the machine onto the conveying belt they are firm and hard. Unlike mineral briquettes, fuel briquettes require no cooling process in order to solidify them.

The Belgium mineral press has also been adapted to fuel briquetting, it being an interchangeable press equally suitable for the briquetting of mineral or fuel products. The plans of this company for a coal briquetting plant equipped with the Belgium mineral press include one dry pan to crush and screen the coal as it comes from the dryer. The fine coal dust is then elevated into a hopper, from which it is drawn into a measure. Opposite this measure is one which measures the binding material, and the whole material to be briquetted is then turned out into a mixer which thoroughly incorporates the binding material with the coal. From the mixer it passes into the press and from there the briquettes, or "eggettes," are conveyed to the elevator and storage bins, ready for delivery to the markets.

Considering the fact that England and the Continent now produce nearly 20,000,000 tons of fuel briquettes annually, largely from waste slack coal which otherwise would be useless, some idea of the importance of the industry there will be gleaned. Already fuel briquettes are being exported from Europe to several South American countries, where they sell as high as $8.00 to $9.00 per ton as against half that sum paid for American coal. The field for the fuel briquetting industry is, indeed, a wide one, and the near future is certain to see the millions of tons of waste coal refuse which has collected about the mines of the anthracite and bituminous coal fields turned to a commercial value through this new industry. Among the advantages of the fuel briquette is its freedom from dust when handled. For marine purposes, briquettes possess the advantage of storing a greater amount of heating power in a much smaller space than is the case with ordinary coal. Tests made of this compressed fuel on railroads in the Western States have been very satisfactory, and the same flattering results have been obtained through long tests conducted in mills and factories.

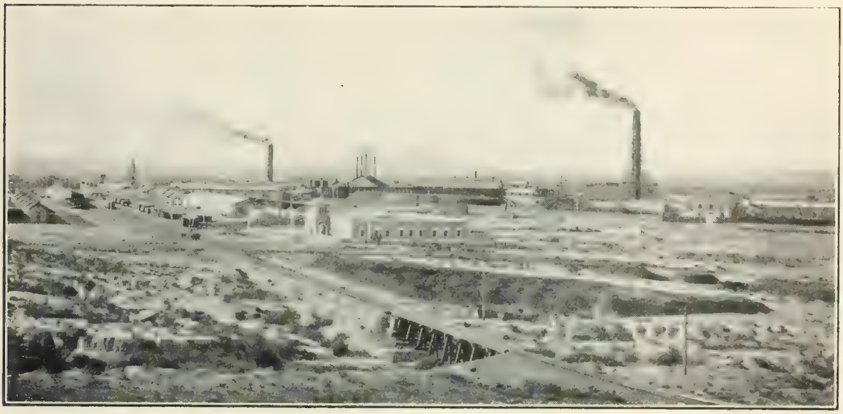
A fuel-briquetting plant for the manufacture of compressed fuel from coal dust and petroleum has lately been installed at Stockton, California, and numerous other plants of various types are now being projected in various parts of the United States, indicating that

BRIQUETTING PLANT OF THE HALL MINES SMELTER, NELSON, B. C.

this important economic fuel industry is about to enter upon a wide development.

Proceeding to those departures made by American genius in the briquetting industry, as noted at the beginning of this article, it appears that of these the briquetting of fine precious-mineral ores and dusts had its first exploitation, and, as already mentioned, an early attempt at briquetting such ores and dusts was made with a brick press, with but little success. Since that time improved mineral-briquetting presses have been perfected, being the same as already described in connection with fuel briquetting, fitted with pockets and plungers to suit the requirements of this modification of the process. The object sought in adapting briquetting to the smelting of fine ores is to obviate the great loss heretofore ensuing from the escape of flue dusts, concentrates, and granulated mineral fines during the smelting process, and to put the fine mineral ores, tailings, and similar fine materials into such a form as will admit of their being treated in the smelter without the great loss which has heretofore resulted. For a long time before briquetting was taken up as the logical solution of this problem by smelter managers, immense sums had been expended in experiments along many lines; but today many large and small smelting concerns in the western States are either operating or installing briquetting plants for the treatment of fine dusts, and in many instances materials which for years have been running down the cañons or into settling basins, are being carried back to the smelters and, after being solidified in the form of mineral briquettes, are being re-smelted with considerable profit. Through the treatment of these mineral fines and of flue dusts and slimes from the concentrators, it has been found possible to increase the smelter output from 10 to 20 per cent., old ore dumps, flue dust, etc., containing as low as 3 to 6 per cent. of mineral value being treated by the briquetting process with much profit. In addition to these advantages, the briquetting industry as applied to fine minerals eliminates numerous disadvantages arising from the use in the smelter of concentrates and fine ores in their natural state.

Aside from the establishment of many briquetting plants at the smelters, many mine owners in the western States have erected briquetting plants at their mines. The blast used in the smelter, while not nearly as strong as that used in a blast furnace for the reduction of iron ores, is still strong enough to force out a large quantity of fine ore in the form of flue dust. In order to catch this flue dust, the gases and fumes from the top of the smelter are forced through long underground tunnels before they are finally emitted from the stack, and in this tunnel a considerable percentage of the dust is deposited. At intervals the tunnel is cleaned, and this deposit after being treated by the briquetting process is again sent to the smelter.



BRIQUETTING PLANT, COMPANIA DE PINOLES SMELTER, MAPINI, DURANGO, MEXICO.

One of the serious difficulties experienced with earlier types of briquetting machines was that blocks of ore after coming from the press could not stand the necessary rough handling between the press and the smelter. However, the improved mineral press, heretofore described, effectually overcomes this difficulty. At Jerome, Arizona, where the United Verde Copper Company has in operation a briquet-

BRIQUETTING PLANT, KENDRICK AND GELDER SMELTER, SILVERTOWN, COLORADO.

ting plant equipped with this type of press, the briquettes are dropped from the end of the delivery belt into a car seven feet below without any crumbling, no intermediate drying process being necessary in this instance. This is only one of the many instances of the successful operation of briquetting machinery as applied to the fine ores. Similar plants are now in operation at the Globe smelter plant of the American Smelting and Refining Company at Denver, Colorado, and at other plants of that company, by the Bingham Consolidated Mining Company of Salt Lake City, the Anaconda Copper Mining Company of Anaconda, Montana, the Hall Mining and Smelting Company of Nelson, British Columbia, the Compania Minera de Penoles, of Mapini, Mexico, and by other mining and smelting concerns in United States, Canada, and Mexico, while American briquetting machinery is now also in operation in Australia and other distant countries. As already stated, the binding material now in general use in briquetting fine mineral is lime. In some of the fine ores of Western America it has been found that no binding material need be added, as they contain just the silicious materials necessary to produce a perfect briquette.

The first attempts at briquetting fine furnace ores and flue dusts date back to the year 1896, when a white mineral press was installed at the plant of the Carrie Furnace Company at Rankin, Pennsylvania, near Pittsburg, and about the same time the Illinois Steel Company began experiments along the same line with a Boyd brick press, which this company is still using for the purpose, having since that time installed an improved White mineral press. In the earliest attempts at briquetting fine iron ores and flue dusts sufficient pressure was not exerted to form solid blocks and no attempt was made to dry the briquettes, they being taken in their green state and dumped into the furnace. Later improvements made in briquetting presses together with the perfection and introduction of automatic drying apparatus, a necessary adjunct in modern iron-ore briquetting, this departure of the briquetting industry has been brought to a high degree of perfection, and is already considered a necessary adjunct of the iron manufacturing industry. Many of the largest iron and steel manufacturing concerns have already adopted the new idea, while numerous other briquetting plants for the utilization of fine iron ores and flue dusts are either being installed, or preparations for their adoption are being made, and in this manner will be turned to the uses of modern industry, those materials which heretofore were not only a decided loss, but which produced many disastrous explosions. Furnaces running with briquettes on the charge run much more regularly and show a marked improvement. Briquettes made of flue dust are delivered in the bins ready to be drawn into the charging bogies, or larry cars, the cost being considerable less than $1.00 per ton, allowing for interest, depreciation of plant, labor, lime, oil, waste, fuel, and drying; and they really take the place of ore costing three times their value per ton, the furnace output when operated with briquettes being equal to that obtained with high-grade ore.

The adaptation of the briquetting industry to iron ores involved the same principles and processes employed in the briquetting of fine minerals. For some years the supply of Mesaba ore in lumps of sufficient size for use in the large blast furnaces has been decreasing, and as the Mesaba ores are very rich in iron and can be delivered very cheaply in Pittsburg and at other centers, they have long had a wide use in the iron industry. They also contain a minimum of phosphorus and sulphur, hence they are lacking only in their physical condition—i. e., they cannot be supplied in sizes large enough to suit the demands of the modern blast furnace. Within the last twenty years the capacity of the blast furnace has been vastly increased. The 150-ton blast furnace was supplanted by that of 300 to 350-tons daily capacity, and this type in turn gave way to the modern 600-ton blast furnace, each of these types being marvels of mechanical and scientific success in their day. Just now, in view of the lack of Mesaba ores of a suitable size for the large furnaces, manufacturers have about come to the conclusion that so far as concerns the increase of the blast furnace, the limit has been reached. Just as long as the supply of lump ore continues the big furnaces will be a success, their operation being conducted on a much more economical scale than was possible with the smaller furnaces of former days. However, even in the large blast furnaces there is a decided loss in form of fine ores and flue dusts, this loss reaching from 40 to 50 tons daily. Giving Mesaba ore a value of $3.50 per ton delivered at the furnaces of the Pittsburg district, it will be seen that the loss in the form of fine ores and flue dusts for a 600 ton furnace amounts to $125 per day. The accumulation of these fine ores and dusts in the furnaces is responsible for many disastrous explosions, jeopardizing life and property. Furnace explosions due to this source are of quite frequent occurrence, and many cases might be cited. The weight and exceeding fineness of Mesaba ores when used in great quantities are certain to cause "clogging," and the ores becoming packed together leaves no escape for the gases, hence the formation of gas pockets resulting in explosions. When these gas pockets are formed near the top of the furnace, enough relief is obtained by blowing out of the top of the furnace; but when the difficulty occurs deeper in the furnace great destruction results.

In view of this state of affairs, the present blast furnace conditions present a most serious question, and one which is now receiving the attention of experts every where. The question involved means either the abandonment of the monster modern blast furnaces or the adoption of briquetting as a relief to present conditions. By this method the fine ores are prepared in solid form before being charged into the furnace, and the fine flue dusts, through a process similar to that involved in treating precious-mineral flue dusts, are to be recovered and turned into use in form of briquettes.

In summing up the progress already made by the briquetting industry, it will readily be seen that this new economic development is destined to inaugurate a new state of affairs in the matter of fuel economy. Great advancement in the reduction of precious-mineral ores has already been made certain through the new industry, while it is early destined to come into wide use in blast-furnace practice. The past has been a period of nurture and experiment rather than one of exploitation for these new ideas, and the progress already made has pretty generally demonstrated to the satisfaction of the manufacturing world their real worth.

EDITORIAL COMMENT

"If people think right, they will vote right," is an axiom among successful politicians. In like manner, industrial managers, and especially the organizers and directors of great industrial enterprises, are beginning to see plainly that to think right on economic subjects is the very basis of all lasting and great success.

It is for this reason that we attach the highest importance to the masterly paper with which Mr. George H. Hull leads this number of The Engineering Magazine. A few years ago, such a discussion would have been appropriate only in the pages of a journal devoted to political science,—would have been the concern of a very narrow circle of students and specialists who devoted themselves to the theories of political economy. But engineers and industrial managers are learning very rapidly in these days that if we are not directly concerned with the abstract theories of political economy, we are very vitally concerned with the concrete and practical problems of industrial economy. For betwixt trade unions, strikes, trusts, combinations, "community of interest," and so on, active men of business are finding it very necessary to be well-informed upon the underlying principles which operate so actively to make good times or bad times in this ordinary work-a-day world. Happily we seem now to have entered upon a season when prudent men can make plans for the future with the assurance of stable conditions for some years to come—provided something doesn't happen! And the thing which now seems most certain to happen, is that unthinking people, and especially uninformed newspaper writers, will soon begin to conjure up the bug-a-boo of over-production.

* * *

In Germany, for example, we have heard much of late concerning bank failures, over-capitalization of syndicates, over-speculation, over-production, and especially a widespread depression in all branches of the electrical industries. The latter fact is worthy of special note in this connection, for it is in Germany that the electrical industries have of late years seen their greatest development. Naturally enough, therefore, upon the heels of this financial and electrical depression in Germany, we have witnessed a panicky disturbance in the copper markets. The market price of copper itself suddenly dropped one-third or more, while the market value of shares in copper companies suffered an even heavier decline. The usual and plausible explanation of the copper disturbance was, of course, "over-production." But the thoughtful man who will read Mr. Hull's scholarly paper must see plainly that the promoters of copper company shares simply attempted to corner the copper market, and, as usual, advanced prices to a point which made the extensive use of copper impracticable. Now that copper has declined sharply, and under natural competition promises to remain at a normal price, we can confidently anticipate renewed activity in the electrical industries, with steadily increasing consumption of copper, and hence, conditions of stability and security in both the copper and electrical industries—so long as normal prices are maintained.

As Mr. Hull points out, precisely the same thing happened in the iron markets two years ago. Owing to a needless scarcity and a senseless boom, the market price of pig iron was more than doubled—was actually carried to a point which forced consumers to stop buying, and, of course, involved thousands of manufacturers in heavy losses. The inevitable result was a heavy falling off in the demand for iron, the abandonment of plans for new enterprises and betterments requiring iron and steel, and with these conditions, a steadily falling market, and the customary senseless cry of "over-production."

* * *

Now, it is high time that this brainless talk of over production were ended, and we feel that Mr. Hull has placed the entire engineering and industrial world under obligation for his masterly exposure of so obvious a fallacy. The political economists long ago demonstrated, in theory, that over-production of useful products is impossible; but to Mr. Hull belongs the distinction and honor of bringing theory home to us in sober, everyday facts. For every word that he has written is simply current industrial history, and it is so ably and so eloquently written that every man who reads and thinks must see the far-reaching importance of his teaching.

Fortunately, also, the managers of the greatest of recent combinations, the United States Steel Corporation, show plainly that they have at least learned part of the wise lesson which Mr. Hull teaches. In their preliminary annual report, lately issued to stockholders, they say this:

> "The demand for the products of the several companies has been so great that prices could easily have been advanced. Indeed, higher prices have been voluntarily offered by consumers who were anxious for immediate execution of orders, but the companies have firmly maintained the position of not advancing prices, believing that the existing prices were sufficient to yield a fair return on capital and maintain the properties in satisfactory physical condition, and that the many collateral advantages to be gained in the long run by refusing to advance prices would be of substantial and lasting value, not only to the companies, but also to the general business interests of the country. The strong position thus taken by the companies for stability in prices, both of raw material and finished products, has had a reassuring effect on the trade, and has contributed greatly toward restoring confidence in the general business situation and creating the present large demand for steel products, by dispelling any doubt as to prices in the future."

Well said, gentlemen! Stick to that program; keep your furnaces, mills and factories running steadily; keep your workmen continuously employed at good wages; keep your customers supplied with all your products at prices that baffle competition—do these things, gentlemen, and all the world will warmly approve of your system, your organization, and your methods of doing business. But, meanwhile, be assured that if you do not do just these things, and do them willingly, as you have so well begun, your competitors at home and abroad will certainly force you to do them. For competition is still the order of the day in all branches of iron and steel manufacture, and it is the part of both wisdom and prudence to take careful note of the significant fact that England, Germany and Belgium—instead of being "out of it"—are knocking hard at the rickety tariff fence which hedges about the "infant industries" of America.

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THE progress toward electrification of the London underground railway drags its slow length along, but sometimes it appears to be headed in the wrong direction. The question of system being at last settled—and we believe well and wisely settled—by arbitration, now new troubles must needs be raised by the rival projects of the component companies, the Metropolitan and the District, for establishing power stations and selling current to one another. It recalls the Apostolic figure of the quarrel among the members, while meantime the whole body suffers. But Mr. Yerkes is again on the ground in person, and in this matter, as in the case of the original difficulties, may find a quick way of sundering the Gordian knot.

These Siamese twins of the railway family really should live more peaceably together, for live together they must. And, as if to frighten them into good behaviour, "the Tube" is seeking powers to build from Hammersmith to the city, under Piccadilly, the Strand, and Fleet Steet, with connecting loops to the Central London line at both ends. This would make a new circle within the circle, underlying the greatest avenues of surface travel in London. Well might one point the Metropolitan-District to this spectre and say, "Now, will you be good?"

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THE discussion of Mr. Orcutt's paper before the Institution of Mechanical Engineers, noticed at length elsewhere in this number, must certainly have impressed most of those present with the fact that the delimitation between so-called American practice and so-called British practice—that is, between smart, up-to-date working methods, ready to seize on every improvement in machinery and every device for labor-saving, and conservative management holding closely to tradition and precedent—that this line of demarcation has become at least a highly irregular one. The new practice has interpenetrated and overspread the old at an infinity of points. It is not merely transplanted, but ingrafted, and is growing up in adaptation to its environment. Any American who thinks Britain is still asleep would himself be suddenly awakened to find British works managers, in so large proportion, keenly alive to the most advanced work being done in Germany or the United States. There is, indeed, some indication that America may suffer ere long as Britain has suffered—from over-confidence in her own superiority and under-estimate of the ability of her rivals to catch up.

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APROPOS of the fallacy of the theory of over-production, noticed elsewhere in these columns, it is interesting to recall the stirring words of the sage of Chelsea, uttered more than fifty years ago, when England was in the throes of corn-law repeal, and at the beginning of free trade.

"What will reflective readers say of a governing class, such as ours, addressing its workers with an indictment of *over production!* Over production; runs it not so? Ye miscellaneous, ignoble manufacturing individuals, ye have produced too much! We accuse you of making above two hundred thousand shirts for the bare backs of mankind. Your trousers, too, which you have made, of fustian, of cassimere, of Scotch plaid, of jane, nankeen, and woollen broadcloth, are they not manifold? Of hats for the human head, of shoes for the human foot, of stools to sit on, spoons to eat with—nay, what say we hats or shoes? You produce gold watches, jewelries, silver forks, and epergnes, commodes, chiffoniers, stuffed sofas—Heavens! the commercial bazaar, and multudinous Howell-and-Jameses cannot contain you. You have produced, produced; he that seeks an indictment, let him look around. Millions of shirts, and empty pairs of breeches, hang there in judgment against you. We accuse you of over producing; you are criminally guilty of producing shirts, breeches, hats, shoes, and commodities in a frightful over abundance. And now there is a glut, and your operatives cannot be fed! Never, surely, against an earnest working mammonism was there brought, by game preserving aristrocratic dilletantism, a stranger accusation, since the world began."

Too many shirts in a world of nine hundred millions of bare backs might well strike others than stern old Carlyle as something quite other than over production; something rather in the nature of defective distribution. All this has been well set forth by Mr. Hull, and this practical application in altogether scientific and engineering manner, of a feature which formed a part of the free-trade struggle in England comes with especial effect at a time when similar forces are at work in other parts of the world.

* * *

The remarkable manner in which the admirable presentation of the advantages of the Panama route for an isthmian canal by General Abbot in the January issue of The Engineering Magazine has been received by the press of the United States and Europe, is a convincing tribute to the interest which is taken in engineering matters by the intelligent public.

The matter is not without its amusing side. The Magazine has been criticised for this publication because it is assumed to indicate a change of front; and reference has been made to the fact that in its pages the points in favour of the trans-continental railways have been advocated by Mr. Nimmo, and the advantages of the Nicaragua route have been set forth by Professor Haupt. Opposed to this is the open statement which has been made, that The Engineering Magazine is the organ of the Panama company!

The Engineering Magazine is the organ of no company, and of no individual. It aims to present all sides of all important questions in which the work of the engineer is involved; and there are few questions indeed to-day in which the work of the engineer is not involved. It has been consistently in favour of the Panama route at all times because that route possesses such manifest advantages as to appeal to engineers in all parts of the world; it advocates that route because it *is* an Engineering magazine. The Nicaragua route has been advocated by the great mass of the unthinking public, skilfully led by able politicians through appeals to sentiment and enthusiasm, while all the time the great majority of the engineering profession, composed of the men who are in a position to understand and appreciate the real merits of the two routes, has known and maintained that the Panama route is immeasurably the superior. Whatever the outcome may be, there can be no compromise between right and wrong, and The Engineering Magazine again affirms, as it repeatedly has before, that the Panama route for the isthmian canal is right, and the Nicaragua route is wrong, and in this opinion it is sustained by an overwhelming majority of intelligent engineers throughout the world.

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We have called attention to the value of the card index system many times in various articles which have appeared in the Magazine, but we desire especially to emphasise the very wide field which is opened for it in industrial establishments by the method proposed by Mr. Falconer in his article elsewhere in this issue upon the numerical method of filing and recording orders. Such a system is applicable to letters, papers, memoranda and data of all sorts, and there is no one who can fail to appreciate the satisfaction which the possession of such a record of information would afford. We commend this paper to all works managers and urge that they experiment with the system in their daily work.

REVIEW OF THE BRITISH PRESS

Modern Machine Methods.

The readers of The Engineering Magazine will doubtless remember the valuable papers written for its pages in 1899 by Mr. H. F. L. Orcutt upon machine shop design and organisation, and welcome further discussion of shop methods from the same pen. Mr. Orcutt has recently presented a paper before the Institution of Mechanical Engineers upon modern machine methods, and in view of his wide and international experience, covering the United States, Germany and Great Britain, his views will be examined with much interest.

Realizing that there is an increasing tendency to minimize hand labour and to reduce manufacturing purely to machine operations by the aid of accurate tools and fixtures, Mr. Orcutt assumes that the lines on which manufacturers will work in the future will mainly be in the direction of perfecting methods of machining. His paper, therefore, dealt with modern machine methods, comparing these with laboriously expensive hand work, or machine work performed upon tools of comparatively simple design unaided by highly developed tools, fixtures and gauges.

There is no doubt that the skilled worker has long since reached the limit of his productive capacity, while the individual, aided by the labour-saving automatic machine, has an output which is practically unlimited. By either method a high degree of accuracy is possible, but accuracy combined with cheapness is possible only under the new conditions, while interchangeability is commercially impossible except in establishments equipped with the best machines tools and gauges.

Mr. Orcutt calls attention to the fact that there are few, if any mechanical operations which may be called new, since turning, milling, planing, grinding and boring are as "old as the hills." It is only the latter-day developments in these older operations which form the subject of discussion, and these, as stated above, have in the main the object of vastly increasing the output while at the same time giving a high degree of accuracy and practical interchangeability of product.

The simplest, and yet one of the most important appliances for enabling workmen of moderate skill to produce accurate and interchangeable work is the limit gauge. Standard gauges are well known and possess many advantages, but there is no way of knowing how closely they have been used by the workman. The limit gauge, however, must go on at one end and not go on at the other, and this assures the superintendent that the dimensions of the piece must lie somewhere between the limits of the two gauges. With such gauges, comparatively unskilled labour will quickly learn to produce accurate work, and the element of judgment, so far as the workman is concerned, does not enter into the matter at all.

Passing from limit gauges to machine tools, Mr. Orcutt discusses the wide range of operation of the milling machine, as compared with its use a few years ago. Improvements in design, and increased skill in the manipulation and care of tools are the two factors mainly responsible for its success. It has largely displaced the planer and shaper, and instead of being used only when a large number of similar parts are required, it is frequently found profitable to set up a machine for a run on ten or a dozen pieces. In order to obtain economical results in milling up-to-date machines must be used, there must be a plentiful supply of good milling cutters and tools, and there must be good tool makers, who know how to keep both machines and tools in the best of condition. This last requirement is by no means limited to milling work. Indeed the essential of modern economical production, next to the use of the best modern tools, lies in the separation of the preparation and care of tools from their operation. A limited number of highly-skilled and highly paid tool makers should be entrusted with the care of the machines and the preparation and care of the tools, and the work of the operatives limited merely to the tending of the machines. In this way the cost of the skilled labour is divided among so many machines as to form but a small element in the production cost, and the great bulk of the labour, which bears a direct relation to the product, may be performed by much cheaper men. Mr. Orcutt describes various milling tools and methods, comparing the product and results with planing.

Grinding, although one of the oldest of machine operations, has been developed as an accurate surfacing method only within the last few years. Now, however, the accurate grinding machine is no longer limited to the tool room, but has found its place in the shop as the cheapest and best machine for producing mechanically correct cylindrical surfaces where good work and interchangeability are required. The turner and the file cannot compete with the grinding machine and the limit gauge. Mr. Orcutt believes that except for heavy work, the grinder and the turret lathe will in the near future absorb 50 per cent. of the lathe work now performed by skilled turners.

The lathe will continue to be one of the most important machines in an engineering establishment, but its work will be materially modified. It seems to be pretty well assured that the lathe in the future will be largely used as a roughing out machine. The boring of holes is now done on the chucking machine; the accurate finishing of plain parts is performed on the grinding machine; repetition work is done on the screw machine; and polishing is transferred to a special department. By making the lathe very stiff, and by flooding the work with lubricant, high speeds and heavy cuts can be maintained, and a great deal of work can be done in roughing out, using unskilled labour, one man keeping two or three lathes in operation. It is found much cheaper to reduce parts in this way than by smith work, and Mr. Orcutt shows many examples of its profitable employment.

The turret lathe is one of the most valuable machines to be found in the modern machine shop, but the lack of skill and training in properly maintaining and using turret machine tools is the greatest obstacle to its more extensive use in all classes of manufacturing, both of the automatic and hand type. With the provision of high-grade tool makers a large amount of lathe work now done by skilled men is sure to be shortly done on the turret machine by comparatively unskilled attendants who will eventually beat the trained turner, in respect to output, accuracy, and uniformity.

Mr. Orcutt closes his paper by a discussion of the use of jigs, small tools, and details of work, and gives some thoughtful words concerning the proper education and training of workmen. Says he: "Politicians and writers are raving over the technical schools of Germany. Speaking as one who has for years been in contact with the product of the German technical school, the author has no enthusiasm nor admiration for their methods; at least, as far as mechanical progress is concerned. Technical education as taught to-day is useless except to a very small percentage of our mechanical workers. There is an immense amount of talk about scrapping old machinery, buying new plant and planning new shops, whilst the most important factor of all—men—is left to shift for itself. Yet all are asking the question, where can I get good men? Train them, is the answer. The means for doing this are in the hands of every manufacturer. In your own shops, on your own machines, with your own instructors in your own time; neither municipalities nor governments can do it for you. Manufacturers must establish systems of apprenticeship which include workshop experience under educational guidance."

The Profitable Sale of Electricity.

It is now becoming generally recognized that the profits from the supply of electric energy depend not alone upon the purely engineering part of the enterprise, such as the station apparatus and outside equipment, nor even upon the management of the plant, but to a large extent upon the methods of charging for the electricity sold.

In the electrical supply business, a plant must be installed large enough to take care of any possible demands, and even under favorable circumstances the maximum load lasts for only a short period, so that during most of the time a large part of the capital invested in the plant is earning nothing. The cost of supplying any quantity of electricity is made up of the fixed charges and of the operating expenses. The former must be incurred before any current can be supplied, and they go on whether any energy is sold or not, while the latter vary with the amount of electricity delivered to consumers. The various consumers use different quantities of electricity and for different lengths of time, so that the cost of supplying a unit varies with the consumers. The most undesirable consumers, from the station manager's standpoint, are those who use the current for only a short period and at the time of maximum load and so increase the "peak" of the load line, while an ideal consumer would be one who took a uniform supply for twenty-four hours of the day and for three hundred and sixty-five days of the year.

The object of the station manager being, then, the attainment of a level load line, it becomes of great importance to inquire whether any method of charging for current can further this object, and a recent paper by Mr. Arthur Wright on "Some Principles Underlying the Profitable Sale of Electricity," read before the Institution of Electrical Engineers, gave a very full exposition of his views and led to a discussion in which a great variety of opinion was expressed.

The author says that before methods of charging for electrical energy can be properly examined, some approximate idea of the cost of generating and distributing it under varying conditions must be obtained, and a large part of his paper is taken up with this part of the subject.

"The cost of supplying electrical energy from a power station can generally be seperated into two very clearly defined groups —viz.: (A) The cost of *getting ready* to supply and distribute energy. (B) The actual cost of *continuing to do so.* These two groups the writer will call, for convenience, *preparation* and *production* costs respectively. The *preparation* costs may be divided into three sub-divisions: (1) The annual cost of the initial capital required to start the undertaking, or the *preliminary* or *formation expenses.* This has generally no very definite relation to the amount of business expected to be done. As the business grows, the annual charge to individual consumers to cover this item of expenditure most obviously rapidly diminish. (2) The annual cost of having to provide and maintain the plant and mains in a condition ready to supply and distribute electricity. These *standing-by costs* vary roughly with the annual maximum load to be provided for. (3) The cost of maintaining the necessary service lines, meters, and attending to consumers' accounts, complaints, and collecting the revenue. These *service costs* are roughly proportional to the number of consumers.

"The *production costs,* or the costs of continuing to produce and deliver electricity to the consumer, are those which actually vary with the amount of electricity distributed from a given power station and set of mains. The production cost per unit sold may be defined as the increment of expenditure incurred by making a given set of plant and mains supply an extra unit of electricity. It can only consist of the following items: (1) the inclusive cost of fuel necessary to produce and deliver this extra unit of electricity to the consumer's premises; (2) the cost of the fuel necessary to keep the steam dynamos running longer per day; (3) the cost of the extra water and oil used, owing to the longer run of the plant and the greater amount of energy supplied; (4) possibly some extra wages cost due to stokers and engine attendants having to work slightly longer per day; (5) the cost of that extra wear and tear of part of the plant which is solely due to the continued running."

The author lays particular stress on the relative smallness of the production costs to those of preparation in most electrical supply businesses, and then proceeds to discuss methods for determining their approximate values for a completed power station which has reached the steady extension stage when additional plant and mains have to be put down year by year to meet the increasing business.

"Although we can thus obtain a fairly accurate analysis of the various items making up the cost of supplying electricity as a whole from the mains, yet before a true profit and loss account can be prepared, we must determine the cost of supplying the individual consumers, and to do this many further considerations have to be taken into account. In the first place, how should the standing-by charges be divided among the consumers, having widely varying requirements as to the amount of plant and mains required for their individual service? The writer thinks most power-station engineers will now agree that it is fair to debit each consumer with the same proportion of the total standing-by charges, as the amount of plant required for his supply during the evenings of the winter months, when the station experiences its annual maximum load, bears to that which would be required to supply the consumers should they all make their maximum demands simultaneously. As to the most practical method of determining the amount of plant, etc., so required by each consumer there are many opinions. Theoretically the best way of determining this data is no doubt some means by which every consumer's daily load curve can be taken and studied, but as this is commercially impossible, the writer is convinced that the next best way is to follow Prof. Kennedy's suggestion of supplying each consumer with a maximum demand indicator, and to make its rate of recording sufficiently sluggish to prevent the registration of any call for current for only a few minutes' duration. In a purely lighting business the majority of the consumers will make their maximum call for plant during the two or three hours in the winter days during which the whole of the plant is most heavily loaded, so that by taking the mean of the six winter months' maximum records so measured, a fairly accurate estimate can be obtained."

The author is the inventor of such a maximum demand indicator, which thus automatically determines what proportion of the plant must be at the service of each consumer. The tariff is then adjusted so as to make the consumer pay his proper share of the "preparation costs," and in addition, pay for the current he actually uses.

Two forms of tariff are proposed. The first is: A charge of x pence per unit for that part of the consumption which is equivalent to the use of the consumers' maximum demand for n hours per year (or quarter or month), and y pence for any further consumption in the said period. The second form is: A yearly or monthly rent per lamp used at the time of maximum demand, and a charge of z pence per unit for the electricity actually consumed.

The second form is very much like the tariff proposed by Dr. John Hopkinson, who was the first to enunciate the principles on which Mr. Wright's system is based. The first form is carried out practically by charging an initial high price per kilowatt-hour on a number of kilowatt-hours equal to the product of the maximum kilowatts demanded at any one time during the period under consideration and a fixed number of hours per day, say one hour or one and a half. The rest of the energy consumed is then charged for at a very moderate rate. Another way of stating the method is to say that there is a low fixed rate per unit on the total quarterly consumption, and in addition, an extra charge in proportion to the maximum amount of current demanded at any one time during the quarter.

The object of this system is to induce consumers to keep their maximum demand as low as possible and to encourage a steady and long-continued use of current.

Mr. Wright's argument is based very largely on experience in the lighting business, in which the load line has a very high peak in the early evening hours. Where there is a large day consumption of energy by motors, or where the load line is levelled in other ways, the benefit of a varying and complicated system of charging is practically lost. In fact, the variation and the complication of the Wright system were the chief objects of attack in the discussion which followed the reading of the paper. The general consumer cannot comprehend the principles upon which the system is based, and he cannot understand at all why his bills have such wide and apparently such inconsistent fluctuations. These objections have led to modifications of the Wright system, with a view to simplifying it, while still preserving the essential principles. At Hastings, for instance, a consumer pays an annual rental of ten shillings per lamp, and, in addition, one and one-half pence per kilowatt hour of energy.

Mr. Wright apparently does not attach enough importance to the storage battery as a load equalizer, while, as a matter of fact, in direct current stations, and in alternating systems with rotary-converter sub-stations accumulators can be employed with a storage capacity large enough to permit much of the machinery to be run continuously at its normal load, when the necessity for any other rate than a straightout flat one disappears.

Mr. Wright's whole method aims to make the tariff for each consumer equal to the total cost of supplying him, plus a fixed profit. There is another principle upon which a system might be based, and which in the long run might result in the "greatest good to the greatest number," if it could be properly applied. That is, making each consumer pay for the current in proportion to its utility to him, or, in other words, "charging what the traffic would bear." To a limited extent, the Wright system does this, but only incidentally, and it would be interesting to see how the "utility standard" would work out when fully developed in practice.

High-Speed Steam Engines.

THE term high-speed as applied to steam engines is altogether relative in its meaning, engines which a few years ago would have been termed high-speed, being now well within the category of medium-speed, while what is high speed in one locality is by no means so in another place. It is also necessary to specify whether high rotative speed, or high piston speed is meant, so that the term is one which should always be qualified when used, so that the user's position may not be misunderstood.

In a paper recently presented before the Liverpool Engineering Society, Mr. John Davidson discussed high-speed steam engines in a very clear manner, confining himself to engines of the quick-revolution type, setting forth their advantages as they are employed in modern engineering practice; especially in connection with the driving of electric generators, and without indorsing all of his views upon this much-discussed subject, we review much of the interesting matter presented.

Mr. Davidson sets forth the general advantages of the high-speed engine as follows:

"Electric generators were first driven by engines of the slow revolution type through gearing—either ropes or belts, etc., but this arrangement is now in almost every case superseded by engines coupled direct to the generators, the majority being engines of the quick revolution type, and thereby the losses due to the intermediate gearing, viz., ropes or belts, have been entirely dispensed with. This means economy in steam consumption, space occupied, and initial outlay for plant. Of course engines for electrical work are not the only ones built of the quick revolution type, as engines have been constructed for many years past, and many are in course of construction, for driving propellers for torpedo boats, etc., where it is absolutely necessary to get the maximum power with the minimum weight of machinery. Engines built for this class of work are of the most excellent design, and the best material possible has been used in the construction of the same, and the author thinks he is safe in saying that the want of extremely quick revolution engines for torpedo boats has led to greater development in design of this class of engine, more even than in those required for electrical work; but there is one difference, and that is, engines for electrical work have to be able to work at their highest speed continuously, whereas engines for torpedo boats have only to work for short periods at full speed.

"The quick revolution engine has long since proved to be a success, and has come to stay, and for electric light and power, the speed at which the engine should revolve is now limited, in most cases, by the builders of the generators, and not by the difficulties expected due to high speed in the engine itself. Engines of the quick revolution type can be thoroughly relied on, and the wear of all parts has proved, after long experience, not to be excessive. An increase in speed in engines has been found to develop many advantages in the way of economy in steam consumption—this economy increasing as the speed increases. Some disadvantages, or what might be described or imagined as such by many people, are, of course, developed, but these are out-balanced by the advantages developed, so they really cannot be taken into consideration."

Comparing the engine of slow rotative speed with the high speed engine of the Willans or similar type, Mr. Davidson calls attention to the large number of parts of engines of the Corliss type, and to the increased size and cost involved in the slower speeds. The disadvantages of the horizontal engine are also set forth, although it is not mentioned that the vertical engine is by no means limited to the high-speed type, and that nearly all of the recent large engines for generating sets in power houses are of the vertical type.

It is interesting to note that in the early history of electric lighting the generators required to be driven at high speed, and hence it was necessary to belt them from slow-speed engines, or design high-speed engines for direct connection. During the period in which the high-speed engine was being evolved a reverse transformation took place in generator design, and at present the large railway generators are constructed to be operated at about the normal rotative speed of large trip-valve engines, or from 80 to 100 revolutions per minute.

Meantime the advance in high-speed engines is making the high-speed dynamo hold its place longer than would otherwise have been the case, and many direct-connected generating sets with high-speed engines and dynamos are made and used with satisfaction. At the same time it must be noted that these installations are for the most part of but moderate magnitude, and that the large units, of 3,000 to 5,000 h. p., are equipped with slow-running engines and generators. It is interesting in this connection to note that one of the best known firms building high-speed engines in England is also making preparations to construct Corliss engines for large powers in addition to the existing facilities for making their excellent high-speed engine.

Mr. Davidson gives some data as to the steam economy of high speed engines, and these give an excellent showing. Thus a Willans engine of 400 h. p. showed a steam consumption of 12.49 pounds per h. p. hour, while a Belliss engine of 250 h. p. gave a steam consumption of 21 pounds per electrical h. p. hour, and a Browett-Lindley engine of 200 kilowatts size required 17.9 pounds of steam per electrical h. p. hour. These results compare most favorably with the economy of slow-speed engines, and when the smaller first cost of the high-speed engines is taken into consideration, the advantages of the quick-running engines, for the sizes for which they are adapted, will be seen.

The high mechanical efficiency obtained with engines of the quick-revolution type is mainly due to the perfect system of lubrication adopted, and the lightness of the parts. There are many other things, however, besides the mechanical efficiency of an engine, which have considerable effect upon the steam consumption per brake horse power, as, for instance, the following:

Jacketting of cylinders.

Whether the steam be superheated or saturated.

Surfaces exposed to atmosphere, and consequent loss due to radiation.

Method of governing adopted, whether throttle or automatic expansion.

Jacketting of cylinders appears to have very little advantage with engines of the short-stroke, quick-revolution type, and the quicker the engine runs, the less appears to be the advantage, so that now the majority of quick-revolution engine builders do not jacket the cylinders, having found that the gain resulting therefrom is not worth the extra expense entailed.

Superheating, of course, has a most beneficial effect in reducing the initial condensation practically to a minimum, according to the degree of superheat used. This applies to both quick-revolution and slow-revolution engines alike. Superheated steam, although used many years ago, appears to have been abandoned owing to the mechanical difficulties caused thereby in the engine itself, and has only recently been taken up seriously as something worth using, and whereby great economy might be obtained.

Respecting the areas of surfaces exposed for radiation and similar losses, on this point the quick-revolution engine scores heavily, and all that may be said here is that the quicker you run the engine the less the surfaces exposed; as the quicker the engine runs the less the size of cylinders required for a given power.

There appears to be little doubt of the advantages of both types of engines, each having its proper place according to the conditions of its operation. For isolated plants and for small stations, using direct-current generators the high-speed engine will probably be always well suited, while for the great stations, using large units of several thousand horse power, the heavier slow-running engine presents advantages which may continue to outweigh those which Mr. Davidson has so fully presented for the quick-running engine.

Alloys of Copper and Tin.

THE reports of the Alloys Research Committee of the Institution of Mechanical Engineers are rightly regarded as classical contributions to the modern store of knowledge concerning the constitution and properties of these important materials of construction, and to these we now have the appendix, as it is called, in the form of the paper recently presented before the Institution by Mr. William Campbell upon the alloys of copper and tin.

These researches were undertaken in order to investigate more fully the freezing point curve of the copper-tin alloys as published in the fourth report of the Alloys Research Committee, and to note the change of structure due to casting.

Without going too deeply into the technical side of this important subject, the general character of the investigations may be here discussed, and the methods of work described, together with some examination of the practical impurtance of the results to the engineer and constructor, while the metallurgist and physicist may well study the original paper as an example of painstaking scientific work.

The original curve of fusibility of the copper-tin alloys was determined by Le Chatelier, and was shown to consist of three branches, changes in direction taking place at 3 per cent. and at 75 per cent. of copper. The later investigations of Sir William Roberts-Austen have added other points to the curve which evidently indicate changes in molecular condition, and it was to investigate the nature and constitution of the alloys at these points that the investigations of Mr. Campbell were undertaken.

By polishing and etching various specimens, their physical constitution may be studied under the microscope, and the object of Mr. Campbell's researches was to prepare the various alloys which showed peculiarities in the cooling curve, and to examine them by the methods of metallography to discover, if possible, the causes of the peculiarities, or at least the structural conditions which accompanied them.

The apparatus used in the researches is fully described in the paper, and consisted of a pyrometer of the Le Chatelier type, the galvanometer reflecting a spot of light upon a scale which could be watched as the cooling took place, and the operation interrupted at any desired temperature. The method of operation consisted in the very careful preparation of the various alloys, their fusion in a double crucible, a smaller one being placed inside of a larger and the space between being filled with asbestos, so as to insure slow cooling. In this way the average time of the fall in temperature from 1,800° to 900° F. was about half an hour. When the melted alloy was removed from the fire, together with the outer crucible and lid, the thermo-couple of the pyrometer was pushed through a hole in the lid, into the molten metal. When the spot of light reflected from the pyrometer showed on the scale the desired temperature, the wires of the thermo-couple were withdrawn quickly, and the inner crucible and its contents plunged into cold water.

By this method a great number of specimens of varying content of copper and tin were obtained, each having been slowly cooled to a determined temperature, and then suddenly chilled, so as to secure the structure at that point, and these specimens were then polished and etched and examined under the microscope. A large number of engravings from micro-photographs of the various alloys accompany Mr. Campbell's paper, and these, with his comments, enable the researches to be intelligently followed. While the study of these must be left for the student who desires to follow the work in detail, some of the general conclusions may here be given.

There appears to be no doubt that most important structural changes take place in solid alloys as the result of heat treatment, and while it may be necessary for the microscopical examination to be supplemented by tensile and compression tests, before the results become fully applicable to the engineer and constructor, yet much of practical value is already shown.

In the course of the discussion, Mr. Milton, of Lloyd's, called attention to the value of the cooling curves of the various alloys as revealing the purity of the metals employed. The researches of Roberts-Austen indicate that in the case of pure metals the breaks which appear in the curves are perfectly horizontal, while with impure metals they are curved, or present rounded corners. The explanation is that at the temperature at which the break occurs a certain number of molecules of a definite compound of copper and tin become solidified and when the temperature falls a few degrees a few others solidify, these being of a composition richer in tin than the first, and forming a layer around them. There are thus formed successive layers of increasing richness in tin, according to the rate of cooling.

The Testing of Steel for Girders.

THE development of testing methods, and the general use of some form of testing machine at steel works at the present time, indicates a great advance over comparatively recent times, when but little accurate or reliable information could be had about the material which went into a given structure. At the same time there are a number of points which may appear to be of minor importance, but upon which, in fact, much of the value of the tests depends.

An article in a recent issue of *The Engineer* upon the testing of steel for girders, brings out some useful and practical features, which may well be repeated and emphasized here.

In the construction of steel girders, the material is usually furnished to the contractor by the steel maker, and tested in the presence of the engineer or his inspector. Here the question of the character of the test piece enters very materially into the reliability of the results. This leads the way to a divided responsibility, since the makers decline to assume responsibility for tests made after the material has left their works, and insist upon abiding by tests made upon their own machines by their own men. The engineer, on the contrary, holds the contractor responsible, and his inspector takes his specimens from the pieces which have been delivered to the contractor, and which may or may not be properly representative of the material as a whole, and these he sends to an independent testing firm or bureau, throwing the brunt of the results upon the contractor. Without throwing any reflections upon any one, it often appears that the testing machines employed by the engineer do not give as satisfactory results as those used by the steel makers. This may depend upon the way in which the machines are handled, or upon the test specimens, and in any case may become a source of dissatisfaction.

In many cases these difficulties are avoided by having the engineer's inspector stationed at the steel works, the material being accepted or rejected upon his reports, but these tests should also be subject, in part at least, to revision upon the machine of a third and independent expert.

It is granted that there should be some sort of a test of the material from each furnace charge, and in this matter the selection of the test specimens should have consideration. In many instances test pieces are taken from crop ends, shearings, and scrap, but there is no evidence that these faithfully represent the material which is under stress in the finished structure. It is not always fully established even that they are from the pieces they are supposed to represent. The most reliable method, but not the most economical, is to take one plate from each charge of the delivered material, and cut the test pieces from the body, the number of plates ordered including sufficient for this purpose.

In this connection attention may be called to the importance of using machines with recording attachments, so that each test piece may be accompanied with its own autographic record. The information conveyed by a record is so far in advance of the mere results of scale readings that no comparison is to be made, and the reliability of recorders now to be had, and capable of being attached directly to the test piece itself, independently of the construction of the machine, is such that there is no reasonable objection which can be urged against them.

In all these matters it is greatly to be desired that the work of the International Association for Testing Materials should be taken into consideration, and that the methods recommended by it should be accepted and used in practical and commercial work. Apart from the value of the work of the association in advancing methods the great importance of making tests in such a manner as to be comparable in all parts of the world is a sufficient reason for accepting the work of this association and standardising both the test pieces themselves, and also the methods of examining them.

REVIEW OF THE CONTINENTAL PRESS

The Prizes of the French Academy.

It has long been the function of the French Academy to decide upon and to award various prizes which have been founded for the purpose of the encouragement of the arts and sciences, and the yearly announcements of these high distinctions are always regarded with interest by scientific men and by those who realize the important part which applied science plays in the conduct of life and the welfare of society.

Among the large number of prizes in the award of the Academy there are several which belong to the field of the work of the engineer. This is to be expected in the department of mechanics, but it is interesting to note that more and more those departments which formerly were ranked in the domain of pure science, are being honored for work which properly belongs to the field of engineering. Thus among the present announcements, under the classification of Physics, Chemistry, and the general prizes, will be found subjects belonging to the domain of the engineer, either as regards their present applications, or for their prospective importance in the immediate future.

Thus the special Extraordinary Prize of 6,000 francs in the Department of Mechanics is divided between Lieutenant Tissot, for his work on the utilisation of wireless telegraphy to naval use, and M. Marbec for his discussion of the computation of the strength of pipes subjected to high pressures. The method of M. Marbec is based upon the elastic theory, and treats of the stresses in the successive laminæ of the material.

The Plumey prize goes to Professor Boulvin, for his excellent work in connection with engineering education at the university of Ghent, and especially for the development of the temperature-entropy diagram and its application to the study of the economical performance of the steam engine. This award will be appreciated by all those who know the good work done by Professor Boulvin, and his paper on the influence of the mechanical laboratory, which will appear in an early issue of The Engineering Magazine, will be awaited with great interest, since the announcement of this award.

In view of the present interest in all that relates to the development of the steam turbine, it is worthy of note that no one of the papers submitted for the Fourneyron prize for a theoretical or experimental study of the steam turbine was thought worthy of award, so that the prize will go over until 1903.

The Montyon prize was awarded to M. Aimé Witz for his general good work in applied mechanics, and those who know the extent of his contributions to applied science will agree in the justice of the decision.

Among the prizes in the department of Physics, the most important, the La Caze prize, was given to M. Curie, who, with his talented wife, has done so much to develop our knowledge of the existence of radiant energy, and to isolate new radiant substances. The Gaston Planté prize went to M. Boucherot, for his improvements in induction motors and for his researches in alternating-current machinery.

The Kastner-Boursault prize for the application of electricity in the arts, was awarded to MM. Gall and de Montlaur for their development of commercial electrochemistry, especially in connection with the electrolytic manufacture of the chlorates of potash and soda. It has been largely due to the efforts of these engineers that the important industry of electrolytic chemistry has been developed in France, resulting in the utilisation of many sources of water power in Savoie and Dauphiné, the present electrolytic production of chlorates in France exceeding 6,000 tons annually, this replacing products formerly imported from England.

An award indirectly connected with engineering is that of the La Caze prize for Chemistry to MM. Wyrouboff and Verneuil, for their work in connection with the isolation of cerium, didyium, and lanthanum from their minerals, together with the investigation of new minerals in which these metals are found. The importance of a full knowledge of the minerals used in the manufacture of incandescent gas mantles is of such importance in connection with lighting by gas and by petroleum and alcohol vapour, that it passes beyond the domain of chemistry and becomes of general technical value.

It has often been questioned whether the offering of prizes really tends to stimulate invention or research, and this point is still open to debate. In fact, nearly all the subjects which have been honored by the awards of the Academy have been undertaken for other ends than the gaining of academic prizes, these rewards coming later. At the same time the fact that the labours of scientific men are ranked with those of the other learned professions in the estimation of the highest tribunal of the nation cannot but have a beneficial general effect upon the ambition of all who devote themselves to science, however disinterested their immediate labours may be. Such a recognition then is to elevate the profession before the entire nation and furthers its work in directions in which it might otherwise be little known.

It is interesting to note that nearly all the subjects which have been selected for award have been discussed and reviewed at length in the columns of this Magazine during their development, so that its readers will find both names and subjects not unknown to them.

Measurement of Engine Speeds.

We have referred in these columns more than once to the increasing attention which is being paid to the closer regulation of the angular velocity of steam engines, this, in some instances, such as the parallel running of alternators, being of more importance than the maintenance of a uniform mean rotative velocity. Various methods have been devised for computing the varying turning moments in engines of different kinds and with one or more cylinders, but the number of elements which must be taken into account renders the accurate computation extremely difficult. Thus there is the varying pressure of the steam on the piston, the varying effect of the inertia of the reciprocating parts, the angular action of the connecting rod as well as its swing in a vertical plane, also the effect of the unbalanced rotating masses attached to the shaft, and all these have to be reduced to the equivalent turning moments at each position of the crank.

In order to check the results of computations, various methods of recording the actual variations in angular velocity have been tried, and the whole subject has recently been presented in a discussion before the Société Internationale des Electriciens, published in the *Bulletin* of the society. From the interesting discussion we may refer especially to the communication of M. L. E. F. David, which from the simplicity of the method described should be extensively known and used.

M. David begins by discussing the variations in the impelling forces acting upon the crank, and examines a number of indicator diagrams, showing the effect of various points of cut-off. With these he examines the effect of the reciprocating parts, and describes the method of reducing the forces to diagrams representing the variations in turning moment on the crank throughout a whole revolution.

If we imagine a crank revolving at the same number of revolutions per minute as the crank of the engine, and having an absolutely uniform angular velocity, this crank being placed by the side of the actual crank of the engine, we can understand that the engine crank would gain or lose in position over the uniformly moving crank. crank. When the turning moment was in excess over the resistance the engine crank would gain, and when the resistance was in excess the crank would lose in position over that of the ideal crank. At any point in the revolution there would be an angular difference in the positions of the two cranks which would be a measure of the difference in angular velocity at that point.

M. David has attempted to devise an apparatus which shall enable these conditions to be realised in practice, and with an excellent measure of success. Briefly, his device consists of a disc attached to the end of the crank shaft, and revolving with it. On the face of this disc, which is about 9 inches in diameter, there is produced an annular surface of smoke and against this smoked surface there is pressed a small stylus attached to one of the prongs of a tuning fork. The vibrations of the fork thus trace waves upon the smoked surface, the amplitude of the waves depending upon the force of the vibrations, and the length upon the speed of rotation of the disc. Since the fork emits a constant note, the successive waves indicate uniform intervals of time, and if the rotation of the disc were uniform the waves would be of uniform length. By removing the disc and fixing the record on the smoked surface by spraying varnish upon it, a graduated circle with equal divisions may be drawn upon the paper, and also radial lines corresponding to equal numbers of waves, the variations between the uniform graduations and those representing equal numbers of waves giving the angular speed variations for the corresponding parts of the revolution, and the speed of the engine may thus be compared with uniform rotation very closely.

M. David gives a number of such records in his paper, and, when studied in connection with the corresponding operating conditions, some very instructive information.

The paper is also especially thorough in its examination of the influence of the weight of the reciprocating parts upon the turning moments upon the crank. Especially interesting is the examination of the effect of the weight of the reciprocating parts for varying loads. A weight which may have an excellent corrective influence at the normal load may become a source of marked perturbations for light loads and early points of cut-off.

In general, the results given by the recording apparatus of M. David show greater angular variations of speed than are indicated by computation. This is to be expected since there are numerous small factors which cannot be taken into account in the computation, but which make up an aggregate sufficiently great to have a perceptible effect. The point of cut-off is not of uniform duration, nor is it the same for both ends of the cylinder, the frictional resistances are not constant, there are variations in steam pressure and vacuum, and in the dryness of the steam, while there are vibrations of the governor and the elasticity of its connections and of other parts of the machinery, and all these enter into the final result, although most of them are impossible of separate determination.

With such a method of record, in which all the elements of speed variation are collected into a final record of the actual effects, the whole subject should be placed in a form for careful study, and the results of various methods of improvement may be put to actual test and record, and the result should be apparent in the practical influence upon steam engine design.

Superheated Steam.

A RECENT paper by M. Nolet, upon the principles involved in the use of superheated steam, is review at length in *La Revue Technique,* and the treatment is so comprehensive that some extracts are here given.

In the first place he calls attention to the imperfect general understanding existing among many as to the real condition of the medium which we call superheated steam. There is no doubt as to what is meant by the terms solid or liquid, but when we come to the expressions "the state of vapour" and "the gaseous state" there is room for misunderstanding.

When water is boiled in a closed vessel until it is entirely vapourised, the steam, from the time it begins to form, is saturated; that is, it possesses the temperature due to its pressure. If after the water is entirely evaporated, heat continues to be supplied, the steam becomes first dry, and then, assuming the pressure to remain constant, the temperature and the volume increase, and the steam becomes superheated. Superheated steam, then, has a temperature higher than that due to its pressure, and in this new state it possesses the same properties as a gas. As a matter of fact the so-called permanent gases are really vapours considerably superheated above their points of saturation.

If now we take the superheated steam, and subject it to the reverse operation, we observe two interesting phenomena. As heat is abstracted the temperature falls without any change in the state occurring. When, however, the temperature due to the pressure is reached, any further abstraction of heat produces a very marked change, it being impossible to remove heat without a portion of the steam being reduced to the liquid state, or, in other words, becoming condensed, and a continued abstraction of heat will result in the return of the steam entirely to the liquid state.

The same conditions, reproduced in the cylinder of a steam engine, will produce the same effects. What, then, will be their influence upon the economical performance of the engine?

From the time the steam leaves the boiler until it is rejected from the engine, a continual abstraction of heat is going on. After the inevitable loss of heat in the pipe through which it passes on its way from the boiler to the cylinder, the steam, at the moment of admission, comes into contact with the walls of the cylinder, always much lower in temperature, since they have been cooled by the exhaust steam which has just left them, and it has been shown experimentally that the initial condensation may range from 20 to 40 per cent. of the total weight of the steam admitted. At the point of cut-off, therefore, instead of finding dry, or saturated steam in the cylinder, capable of giving the best results, there generally exists a mixture of steam and vapour of water.

Many attempts have been made to remedy this state of affairs, among which may be mentioned the use of the steam jacket, by which a fresh supply of heat is given through the lining of the cylinder.

The use of multiple expansion, in two or more cylinders, has also been extensively used, this preventing the incoming steam from meeting directly the walls which have just been cooled by contact with the exhaust steam. All such methods, however, are but palliatives, acting after the harm has been done, and capable of remedying it in part only.

This whole subject was investigated very thoroughly by Hirn and by the studies of the Ecole Alsacienne, and the result showed that the heat balance deduced from the heat exchanges going on in the cylinder invariably indicated a material loss of useful work.

The true remedy for these losses appears in the superheating of the steam before it enters the cylinder, thus permitting the inevitable reduction in temperature to affect the temperature of the steam without affecting its state. Hirn expressed himself in this respect in no uncertain terms. In his Théori Mécanique de la Chaleur, he says: "In the more or less remote future, when a sensible and rational progress in applied mechanics shall triumph over mere routine, the use of superheated steam will inevitably replace that of saturated steam, especially in cases where economical power is demanded." Since the time of Hirn, these principles have been advocated by Sainte-Claire Deville, Troost, Wethered, Siemens, and many others equally celebrated, and within the past few years the use of superheated steam has gained many advocates among practical men.

The principal practical difficulties which have been encountered in the use of superheated steam have been with the apparatus for superheating, and with the action of the highly heated steam upon the valves, packing, joints, etc., of the engine. For these reasons, superheating, which was tried extensively in England from 1850 to 1860, was then given up; but, as M. Nolet well puts it, it was not superheating, but rather superheating apparatus, which was abandoned.

At the present time there are several superheating devices in the market, designed upon scientific principles, and capable of providing steam superheated at least 200° C. above the temperature due to the pressure. Lubricants are readily obtained which will resist these temperatures, and with engines, designed for the use of superheated steam no difficulties are experienced in daily operation. The steam and fuel economy obtained by the use of superheated steam reaches 20 per cent., and in many instances this economy enables one or more boilers in a battery to be dispensed with, thus effecting an additional economy in the labor of firing.

In this connection it may be worth while to call attention to the fact that in engines for use with superheated steam the disposition of metal in the cylinders and valves may have an important effect upon the satisfactory working. Engines in which heavy masses are cast in one piece with the body of the cylinder are apt to be warped out of truth by the heat, while large flat slide valves, or long Corliss valves, may be found difficult to keep tight. The best results are obtained with poppett valves which open by direct lift without any sliding action, and with care such valves may be so arranged as to permit a uniform heating of the entire cylinder and valves chest. It is interesting to note that the steam turbine, by reason of its entire freedom from rubbing surfaces, or the need of any sort of lubricant, is the best type of engine for use with superheated steam, and experience has shown that a marked economy results from its use.

The Transformation of the Merchant Marine.

In an exhaustive review of the present situation of the merchant marine of the world, presented before the Eighth Congress for Navigation by M. Vétillart, and published in the *Annales des Ponts et Chaussées,* the transformation which has been made in recent years is especially discussed, and the limitations imposed by existing port facilities are brought out.

M Vétillart prefaces his paper with the statement that the present La Barre dock at the port of Havre was built in the same year (1807) in which Fulton started the Clermont on her trips between New York and Albany; the entrance of this important dock, which has served from that time until the present, being 13.64 metres (44.75 ft.) wide at the top, 11.69 metres (38.35 ft.) at the bottom, and with a depth of 6.70 metres (22 ft.) over the entrance still at mean high water. These dimensions were ample for the vessels of that day, the breadth then rarely attaining 10 metres, and the draught being less than 5 metres.

In 1899 the plans for a new dock were commenced, and work upon it has since been begun. This will have a width of 30 metres (98.42 ft.), and a length of 240 metres, 787.4 ft.), with a maximum depth of 9.65 metres (31.66 ft.) over the sill at high tide. These dimensions will admit vessels similar to the Oceanic or the Ivernia, of which the displacement exceeds 20,000 tons.

These figures indicate the changes which have taken place in the dimensions of merchant vessels during the past century, and indeed most of the increase has been in the last quarter of the century, while it is still progressing, and bids fair to continue.

Reviewing the causes which have led to the increase in the dimensions of merchant vessels, M. Vétillart rightly attributes it primarily to the advent of steam navigation, but there are also other conditions both constructive and commercial, which have aided in the growth in the dimensions of ships.

In the early history of steam navigation steamships were used for voyages of moderate length only, but with the improvements in the propelling machinery, securing such an economy of fuel that the eceonomical steaming radius was greatly increased, the use of steamships for heavy cargo transport over long distances introduced a new factor in marine traffic. Apart from the commercial importance of providing large vessels, the relation between size of hull and proportional power required for propulsion enters into the problem. The greater relative economy of motive power to burden in large vessels has contributed largely to the increase in dimensions, and in the competition for ocean freights the large cargo steamer has easily taken the lead.

The limitations of port facilities having been early reached as to width and draught, it remained only practicable to increase the displacement by increasing the length. In the early sailing vessels the ratio of length to beam was almost always included between 3.60 and 3.80. Some of the fast clipper ships were made of a length equal to 4.5 to 5 times the beam, and in the last of the wooden transatlantic steamers the ratio of length to beam reached 6 to 7. At the present time, with steel construction, the ratio has increased to 10 or 11, the limit mainly being found in the increased tendency to vibration, injurious alike to hull and machinery, besides causing discomfort to the passengers.

Among the changes which may be noted in ship construction during the period covered by the paper of M. Vétillart is that of the modification in weights. The introduction of iron for the hull construction caused a reduction of about 10 per cent. in weight over that of a wooden hull of the same displacement, and the use of steel caused a further reduction of 10 per cent. The old wooden hulls weighed about 50 per cent. of the total displacement, while the present steel cargo steamers weigh about 30 per cent. of their displacement. The hulls of the modern transatlantic liners weigh about one-half of their total displacement, but this is due to the numerous bulkheads, and the general solidity demanded for the high speeds and heavy stresses to which they are subjected.

The machinery of the earliest steamships, operating at very low pressures and slow speeds, with rectangular boilers, weighed about 800 kilogrammes (1,760 pounds) per horse power! Even as late as 1860 the weight was as high as 500 kilogrammes (1,100 pounds) per horse power. At the present time the weight of the propelling machinery in the express steamers is about 250 to 300 kilogrammes (550 to 660 pounds), and in the cargo steamers about 200 kilogrammes (440 pounds) per horse power. There has thus been made a reduction in weight to one-third or one-fourth that of 40 years ago. Of course far greater reductions have been made in the weight of the propelling machinery of torpedo boats and destroyers. Thus, for example, the machinery of the Forban, by M. Normand, weighs only 16.7 kilogrammes (36.8 pounds) per horse power; about equally divided between the engines and boilers. These reductions in weight have been obtained by several means, among which may be mentioned; the substitution of the screw propeller for the paddle wheel; the introduction of high-speed direct-acting engines, in place of the older, slow-moving machines! the substitution of cylindrical boilers, and consequent increase in steam pressure; and the use of forced draft.

To these should be added the improvements in metallurgy, by means of which stronger and better materials of construction have been provided; permitting the use of steel castings and forgings, the use of nickel-steel, etc.

A most important advance is that which has gradually been made in the consumption of fuel, this affecting not only the economical performance, but also the space required for the carrying of fuel.

The early low-pressure engines required about 28 kilogrammes (62 pounds) of water per h. p. hour, and 4.5 kilogrammes of coal (10 pounds). At the present time the propelling machinery of ordinary cargo boats requires but 7 to 8 kilogrammes (15.4 to 17.6 pounds) of water per horse-power hour, and a consumption of but 0.8 to 1 kilogramme (1.76 to 2.2 pounds) of coal.

The progress in fuel economy may be attributed to the use of the surface condenser, to the use of improved boilers, and the employment of multiple-expansion engines, thus permitting the production and utilisation of much higher steam pressures than formerly, as well as higher degrees of expansion without proportional loss from cylinder condensation.

M Vétillart deduces formulas for the various relations between size, speed, power, fuel consumption, etc., from which it is possible to determine the most advantageous arrangement for any required service, and a study of this portion of his paper should lead to the application of scientific principles to questions hitherto considered almost wholly commercial.

The result of all this progress which has been made in the construction of large merchant steamers is the realisation of the necessity for the improvement of harbours and channels. Those ports which desire to secure or retain the commerce of the world must provide a depth of at least 9 metres of water (29.5 feet) and indeed great freighters such as the "Pennsylvania," when fully loaded, draw 9.75 metres (32 feet), and unless provision is made at existing ports for the accommodation of such vessels, it must be expected that the traffic will go elsewhere. It is to the engineer that commerce must look for its progress in the immediate future, as it has many times in the past.

Experiments on the Propulsion of Ships.

The great value of the testing tank as a means of obtaining data for the powering of ships and for the comparison of various hull models, is now firmly established, and a number of such tanks are in constant use in Europe and America. These tanks thus far have been operated upon the method originally suggested by Froude, the hull being modelled in paraffine or wood and drawn through the water by mechanism which measures the resistance of the model and the speed of its motion. The relation of these measured quantities to those for the full sized hull may be reduced to formulas for ready application, so that the resistances for various speeds may be experimentally determined, and the powering, or the influence of changes in model, be practically studied.

The information obtained by this method, while of the greatest value, does not reveal anything about the behaviour of the propeller, but leaves this to be deduced from the resistance of the hull.

It is now proposed by Ing. Nino Pecoraro, in a paper in a recent issue of the *Rivista Marittima,* to provide models in the testing tank with screw propellers, driven by electric motors, thus enabling the propelling forces to be determined in terms of the revolutions of the propellers. In this way it is proposed to determine points in curves which shall show the number of revolutions of the screw corresponding to various speeds, and also curves showing the efficiency at different velocities.

The earlier experiments in this direction, made in the testing tank at the arsenal at Spezia, did not have the propeller mounted on the model. Instead, the propeller was carried by a light framework carried on overhead track, the motion being transmitted by a vertical shaft extending down into the water, and connected to the propeller shaft by a pair of bevel gears. The propeller thus pushed the model along, but was itself carried by the separate framework. This method naturally introduced disturbing factors, such as the resistance of the water to motion of the shafts and gears, as well as to the immersed portion of the framework by which they were carried. The errors have been entirely eliminated by the improvement of placing an electric motor in the model, the current being taken from feed wires running the entire length of the tank, the regulation being controlled entirely by the observers. The power supplied may be measured electrically to a high degree of precision, and the speed regulated and recorded, both as to the revolutions of the propeller and the speed of the model. Since the resistance of the latter may be previously determined by towing it in the usual manner, the efficiency of the propeller is given, and experiments may easily be made with propellers of various forms.

Signor Pecoraro gives details of tests made at Spezia with two models about 14 feet long, one having a single screw and the other provided with twin screws, and comparisons between these models using the older apparatus with the propellers suspended from the separate framework. and the improved arrangement with motors in the models, showed the losses due to the resistance of the suspended apparatus.

The paper contains a mathematical analysis of the relations between the model apparatus and the full sized ships, and numerous curves are plotted to show how general results may be obtained from a limited number of experiments.

The application of the testing tank to the study of the action of screw propellers cannot but furnish much valuable information in connection with the propulsion of ships. Although a vast amount of study, theoretical and practical, has been given to the screw propeller, the real performance of any screw is uncertain until it has been placed in the ship and given an actual trial. If the effect of diameter, speed, pitch, shape and surface upon the performance of a screw propeller can be obtained in the testing tank; and, furthermore, if this knowledge can be obtained in connection with the actual resistance of the hull in which the screw is to be placed, one of the chief elements of uncertainty in the predetermination of the speed of a proposed vessel will have been removed.

The trials in the testing tank should supplement, not replace to mathematical study of propulsion, and in no case should such a useful auxiliary be permitted to replace analysis, and allow the indiscriminate use of empirical methods of design and proportion; rather should the experiments be used to check and confirm the theoretical deductions, and be guided by them from inception to conclusion.

Water-Tight Compartments on Ships.

WITH the increasing size and speed of steamships there has come increased attention to the details upon which depend both strength and floatibility, the importance of freedom from disaster being fully appreciated both by constructors and by the travelling public.

Among the recent propositions for improvement in the construction of ships, we note the recent paper of M. E. Duchesne, presented before the Société des Ingénieurs Civils de France, and published in the *Mémoires* of the society.

M. Duchesne, by virtue of his long experience as expert engineer of the Bureau Veritas, as well as because of his wide acquaintance with all departments of marine construction, is entitled to an especial hearing, while the novelty of his ideas must not be permitted to deter the most conservative from a careful examination of their soundness.

A ship consists essentially of two distinct structures, one being a girder, resisting by its structural strength the action of the winds and waves, and stresses due to the motive power, the other, the hull, opposing by its tightness the entrance of the water to the passengers, merchandise, and machinery. Under the present system of construction these two structures, although independent in their functions, are combined in one and the same, the hull being at the same time the girder and the water-tight shell. The necessity of this combination is obvious for vessels of moderate size, and indeed in such cases it offers decided advantages over any other method, but with the increasing size of vessels the conditions become modified.

In the present system of construction each portion is dependent upon the other. If, by any accident the hull of the ship is damaged the water rushes in. In like manner the stresses which heavy seas necessarily inflict upon a long hull produce deformations which mav cause serious leaks. The principal improvement which has been made is the introduction of a number of transverse bulkheads with water-tight doors; these, when closed, separating the ship into compartments limiting the inflow of water to the section in which the break occurs.

M. Duchesne proposes to separate the two elements of the ship to as great an extent as practically possible. The system which he advocates is really an extension of the present double-bottom construction, and contemplates the construction of a complete water-tight inner hull, about two-thirds of the length of the ship, and having a space of three or four metres between its bottom and the main outer hull. This inner hull is stoutly made and heavily braced within, and is connected to the outer hull by partitions and braces, these latter, however, being made of mild steel, and not so rigidly braced as to transmit excessive deflections to the inner hull. The outer hull, therefore receives the action of the waves, and is made amply strong to resist them as understood in present methods of construction, but should leaks occur through straining or buckling, or should there be a collision, the inner hull would afford perfect security against sinking.

The engines, boilers and all machinery, M. Duchesne proposes to place in the inner hull, together with a portion of the coal, sufficient for at least one day's run, while the remainder of the coal may be placed in the space between the hulls. This space is sufficiently wide to permit of its being used for cargo, passengers, etc., and in appearance it would not differ from the rest of the ship, except that there would be no general communication between it and the inner hull without going above the water line and again descending. All the first-class accommodations would be altogether above the water line, and in general there would be no external indication of the special construction.

The inner hull would contain the usual water-tight bulkheads, and a limited number of water-tight doors would afford communication between the inner and outer hulls for the passing of coal, etc., but these could readily be controlled by automatic mechanical appliances, such as are now employed in existing bulkhead arrangements.

There is no doubt that greatly increased safety would result from such a construction as that suggested by M. Duchesne, but it appears to have its limitations. In the first place it is adapted to large vessels only, since there would not be sufficient space in moderate sized ships for an inner hull large enough to float the entire structure. At the same time the advent of the large passenger steamer is sufficiently assured to render this point of minor importance. The question of additional cost would be met, M. Duchesne believes, by the higher prices which could be charged for transport on vessels known to be non-sinkable; and in support of this view he calls attention to the high prices which are now obtained on the larger and safer ships.

REVIEW OF THE AMERICAN PRESS

Industrial Education in America.

At a recent meeting of the Engineer's Club of Philadelphia there was held a most instructive symposium and discussion upon the important subject of industrial education, with especial reference to the needs of the United States, and from the *Proceedings* of the club, we extract some of the more important points made.

The original papers of the symposium were contributed by Professor Edgar Marburg, of the University of Pennsylvania, Mr. S. M. Vauclain, of the Baldwin Locomotive Works, and Mr. J. M. Shrigley, of the Williamson Trade School, of Philadelphia.

Accepting the fact that the old apprentice system is obsolete, and deservedly so, the discussion proceeded on the lines of the necessary schools, and their co-operation with the machine and the building trades. The transformation which has taken place in those trades is necessarily reflected in the methods of education. As Professor Marburg well says: "Industrial education stands to-day where technical education stood a brief half-century ago. While the provision for the latter leaves little now to be desired, the former has been almost wholly neglected. The general introduction of highly specialized machinery, the standardization and endless duplication of parts, the centralization of work in enormous factories—all these influences have resulted, it is true, in a cheapening of the output, but also in the cheapening of the workman. The vast majority of so-called machinists to-day are in reality machine attendants. Year in and year out they are confined to the operation of some single piece of mechanism—a service requiring a modicum of experience and individual skill. Such men are, in fact, little more than automatons, pursuing a certain narrow course of duty in an all but mechanical fashion."

This side of the picture is not all, however, since the tremendous expansion of manufacturing interests has given rise to a demand for a much higher class of skilled artisans, men who understand how to care for the highly organized modern tools, and provide them with tools and equipment to enable unskilled labor to attend them. The increasing attention which is given to advanced systems of works-organization has also created a demand for men of suitable qualifications for the positions of foremen, superintendents of departments, and managers of works. The demand for competent men of these higher classes is far in excess of the supply. Such men require, in addition to a varied and extended experience in the shop, a sound knowledge of the fundamental scientific principles pertaining to their various lines of work.

The graduate of the technical school possesses the latter qualifications, but he has not the necessary knowledge of shop practice. As a rule such men are disinclined to enter the shop after they leave college, but look at once for higher positions and better wages, while at the same time the influence of the labor unions is exerted against the invasion of what they consider their proprietary domain, by such intruders.

Mr. Vauclain, speaking as the representative of a great engineering establishment, maintains that the workshop is the true manual training school, and holds that the public and high schools should furnish a thorough training in the fundamental principles of mathematics and the physical sciences, and that the manual training could then be well furnished in the workshops of the nation, if the latter would rise to their opportunities. In the Baldwin Locomotive Works, there are many young men who have entered for the express purpose of adding to their school or college training the practical shop experience which is needed to make them all round workmen, superintendents, foremen, and managers. During this training period they receive enough to pay their living expenses, and at the end of two or three years they are far and away ahead of any apprentice under the old seven years' indentures. A special superintendent of apprentices is occupied in seeing that these young men are given the opportunities to learn the various branches of the work and that they are not kept too long upon any one branch because they have shown a special aptitude for it.

The general outcome of the symposium was that industrial education may properly be divided into two departments; first, the general foundation, consisting of a good school education, with such a thorough grounding in mathematics and the physical sciences that the pupil may thereafter be able to continue intelligently any future studies to which his work may direct him. This portion of the education should be furnished by the public, in the public schools. Second, the practical shop training, which it should be the clear duty of the manufacturers to give along with the employment which they can furnish to the bright boys who are to become their most valuable skilled workmen. The manufacturers are not to suppose that this is any act of philanthrophy on their part; on the contrary, they will become the chief beneficiaries of the system, since it is by this method that their demand for skilled workmen, foremen, and superintendents is to be answered.

Modern automatic machinery has undoubtedly made it possible for much of the old-time manual skill of the machinist to be replaced by the invariable product of the improved tool, and rendered it practicable for such tools to be tended by comparatively unskilled labor. At the same time the transformation has created a demand for labor of a much higher grade of skill, including a fundamental scientific training combined with such skill of hand as shall be capable, not only of performing the mechanical work, but of devising methods, of distributing the course of work through the shop, of accounting for every item of its cost, and of maintaining the entire equipment of an establishment up to the very latest standards of efficiency, capacity, and perfection of product. This is a degree of industrial training of which the advocates of the old apprenticeship system had no conception, but it is the demand of to-day and will be the realization of to-morrow.

Smoke Abatement.

There have been many attempts to enact and enforce smoke prevention ordinances in American cities, and those who are interested in such movements may well take courage at the success which has attended such efforts in two cities at least, in St. Louis, and in Cleveland.

The progress of the good work in St. Louis is discussed in a paper presented before the Engineer's Club of St. Louis by Mr. W. H. Bryan, and published in the *Journal of the Association of Engineering Societies.*

St. Louis is naturally a smoky city, not only because of its many and varied industries, but also because of its close proximity to the soft coal beds of southern Illinois, from which it derives much of its supply of fuel. These coals are most plentiful and cheap, but they leave much to be desired in other respects. They are high in volatile matter, moisture, and ash, and are low in calorific power, and are altogether favorable to the production of smoke, unless proper methods of prevention are adopted. It is naturally the duty of the engineer to encourage the use of the most economical fuel, and at the same time to show how the nuisance of smoke production may be avoided.

The Engineer's Club of St. Louis, with which Mr. Bryan has long been identified, has been most active in endeavoring to aid in the prevention of smoke within the city, and while always advocating the enactment of ordinances to further that end, its members have felt that the best work could be done by educating the public and by encouraging the development of improved furnaces. The whole idea of the work of the club was to show that the prevention of smoke by modern methods inflicts no hardships on industries, but may, on the contrary, conduce to increased fuel economy.

It is impracticable here to go into the local methods which were employed in St. Louis, other than to state that the combined efforts of a citizen's committee and of the Engineer's Club resulted in such a marked abatement of the smoke nuisance that it has been determined to make the smokeless burning of coal one of the noteworthy features of the coming Louisiana Purchase Exposition.

Broadly speaking, there are three methods of stopping the production of smoke: First, the shutting down of smoke-making plants; second, the use of smokeless fuels; third, the burning of ordinary fuels smokelessly.

Although it may seem that little good could be accomplished by the actual shutting down of plants, it really seems as if this method might ultimately result in the complete solution of the problem. Those establishments which were compelled to cease the production of smoke have for the most part introduced electric power, drawing their supply from the large central stations, situated at a distance, and provided with smoke-preventing appliances. Ultimately this indicates the removal of all power generating plants from the cities, and their location at the mines; the power being transmitted and utilized electrically.

In the meantime, various forms of smokeless furnaces have been introduced, with good results. Among these, Mr. Bryan mentions the following:

Steam jets, which are the simplest form of smoke prevention appliance; coking furnaces, with firebrick arches, enabling complete combustion to take place before the products of combustion are permitted to come in contact with the comparatively cool surfaces of the boiler; down-draft furnaces, in which the products of combustion are compelled to pass through the fire in the reverse direction from that usually followed; automatic stokers, including underfeed devices and travelling chain grates; and finally, powdered fuels. All of these may be shown to give good results, and in the city of St. Louis many of them have been installed with the result of rendering that city far freer from the smoke nuisance than would have formerly been considered possible.

The state of affairs in the city of Cleveland is well described by an article by Professor C. H. Benjamin, in a recent issue of the *American Machinist*. Cleveland has vied with St. Louis in being one of the smokiest cities in the United States, but thanks to the efforts of energetic citizens like Professor Benjamin, much of this clouded reputation has been removed. This result has been accomplished by the creation of a separate division of the city government having the matter in its sole charge. Under the supervision of Professor Benjamin, a thorough canvass was made of the entire city and an expert observer was detailed to report upon the worst smoky chimneys, the records being taken upon card index forms for filing and reference. The manufacturers were then approached and the subject discussed with them intelligently and carefully, without any attempts at persecution, especial emphasis being laid upon the economy which would be effected by good combustion.

The very small quantity of suspended carbon which is needed to produce dense smoke has been made a reason for statements that smoke prevention could not result in any material saving in fuel; but, as Professor Benjamin shows, the production of smoke is in itself an indication of imperfect combustion, and with the smoke there is also discharged a large proportion of carbonic oxide, this, although transparent, meaning a material loss due to the partial combustion of the fuel which it represents. The result of this campaign has been the introduction of improved furnaces and of better methods of firing, so that at the present time the smoke produced has been reduced to about one-fourth of its former value.

The experience in Cleveland has shown that the diminishing of the smoke nuisance has been accompanied with a reduction of 15 to 25 per cent. in coal bills, and this, as well as the interest of manufacturers in the welfare of the city has aided in the efforts to purify the atmosphere. This economy is the result, not only of the more complete combustion of the fuel, but is also in part due to the improvement in boiler efficiency by reason of the diminished fouling of the flues by soot.

There is little doubt that no more powerful incentive toward the abatement of the smoke nuisance can be offered than a demonstration of its fuel economy, and this has been fully demonstrated by the results in Cleveland.

The Supporting Power of Piles.

The extent to which piles are used in important foundation work renders it most desirable that some means should be provided for determining the safe load which may be put upon them in any given case, and many authorities of high reputation have produced formulas for such computations.

In a paper recently presented before the American Society of Civil Engineers, and published in the *Proceedings* of the society, Mr. Ernest P. Goodrich has collected these numerous formulas, and examining the assumptions and data on which they are based, he has produced a general formula in which the previous ones are included.

In order to demonstrate the errors and the reliable elements in the various formulas Mr. Goodrich has devised an apparatus for use with a pile driver which should record the vertical motion of the pile, the time occupied by this motion, the velocity of the hammer as it strikes the pile, and of the pile at each instant of its movement, and also the amount of compression of the head of the pile from the blow of the hammer. This ingenious apparatus is so arranged that the various movements are recorded by a curve drawn on a piece of smoked glass, while intervals of time are recorded on the same glass by the vibrations of a tuning fork of known period. Many such diagrams are given in the original paper, and the results compared with the computations of the formulas, the curves having been examined with a Coradi graphical integrating machine enabling the curves representing the differentials of the originals to be obtained.

The result of these investigations is the deduction of a formula which is far closer than any of the others, except Trautwine's, to the observed results, this formula, expressed as a rule, being that the supporting power in pounds is equal to ten times the hammer weight, multiplied by the height of the drop, divided by three times the penetration at the last blow.

Mr. Goodrich makes some recommendations regarding tests of the supporting power of piles, which if followed would make the results of various observers comparable, and enable the existing formulas to be revised or sustained. The principal point is that a uniform drop of 15 feet be adopted for the hammer, since this gives a good penetration within the limits of ordinary conditions, and is adapted for existing pile-drivers. The following specification is also recommended:

"Piles shall be driven to such depths that the last blow of a 3,000-℔ hammer freely falling 15 ft., shall not produce a penetration greater than 1 in., or an equivalent penetration directly proportional to the weight of the hammer." It is believed that such piles will support an ultimate load within 10 per cent. of 75 tons; and that designers can more easily determine the necessary pile spacing and the most desirable factor of safety to be used in individual cases, and make the pile-drivers follow a standard specification, than otherwise.

The Bohio Dam.

In all of the discussions relative to the construction of the Panama canal, the Bohio dam has played a conspicuous part, and the magnitude and difficulties of this work have been set forth as important objections to the Panama route. For this reason the important paper of Mr. George S. Morison before the American Society of Civil Engineers, published in the *Proceedings* of the society demands especial notice at the present time. The eminence of Mr. Morison in the especial department of engineering to which this work belongs, and the fact that he is a member of the Isthmian Canal Commission, which has advocated the selection of the Panama route, lends especial value to his utterances.

Admitting that the neighborhood of Bohio is the only available location for the dam by which the summit level of the canal must be maintained, there are differences of opinion as to the precise location to be selected; and as to the manner in which the dam should be constructed.

The high banks of the valley are near together at Bohio, and the rocky character of the sides renders the location apparently an ideal one for a dam. Borings reveal, however, that the alluvial bottom has simply filled up an old deep geoligical valley, and that the lower portion of this valley, to a depth of 140 feet in some places, is filled with sand and gravel permeable to water.

The original plan of the French engineers was to build the dam at the narrowest part of the valley, opening the ground to a varying depth, not beyond what could be done with open coffer dams, and to build an earth dam of compact material, without a core wall. This dam was to be 15 metres wide on top, and the down-stream face was to be faced with rip-rap and the up-stream face with concrete. A concrete wall was to be built across the river at the foot of the upstream face, this wall to be built between two lines of sheet piling. Such a dam, like other earth dams, would not be safe against an overflow, but would be tight in itself, and the only loss of water would be that which would percolate through the permeable material in the valley below the bottom of the dam.

The present Isthmian Canal Commission has adopted a plan of a dam intended to be absolutely tight in itself, admitting of no seepage either through, or below it. This involves the selection of the location showin the minimum depth to bed rock below, the borings indicating this to be 129 feet deep. The method of construction is proposed to consist of a series of pneumatic caissons, sunk to the rock, these caissons forming the foundation of a solid concrete wall, the two together constituting the core wall. This would undoubtedly make a most complete construction, but it would involve the extension of pneumatic work to unprecedented depths, and would be by far the most costly form of construction proposed.

The plan suggested by Mr. Morison is different from either of the preceding, but resembles the French design in that it proposes to permit the seepage to pass through the permeable soil beneath the valley. The general arrangement of the plan includes two rock-fill dams, one situated about 200 feet above and the other about 2,000 feet below the French location. The space between the two rock-fill dams would be filled with impermeable material, the two dams being retaining walls which would hold the earth in position. This would practically convert the dam, or rather pair of dams, into an extended piece of land, forming a shore or bank to the artificial lake thus formed. Two lines of sheet piling, driven as deep as practicable, probably about 50 feet, would be used below the first rock-fill dam, these preventing a large portion of the seepage through the permeable soil of the old valley, but below this the seepage would be permitted, it being not so much but that it would be made up by the stored supply of water, while the extent of the whole structure would render it safe against any destructive effect from this cause.

In any case there is provided a natural spillway over a low summit which separates the Chagres river from a local tributary, the Gigante, and there is an excellent site for the necessary construction works about 2 miles below the site of the dam.

Mr. Morison's paper contains sections of the various proposed dams, and a map of their locations, with details of the various estimates, as well as much valuable information concerning the temporary works necessary during the construction of the entire work. The whole forms a contribution to the literature of the isthmian canal projects which is refreshing in that it deals directly with the engineering problems, devoid of any speculation or sentiment, assuming that the Panama route is the true engineering solution of the question, and showing how what is considered its most difficult problem is one which has been thoroughly mastered in more ways than one.

American Fuel Oil.

The extensive developments of the fuel-oil-wells in Texas, render the results of the report of tests made upon the fuel value of Beaumont oil by Professor Denton, of present interest.

The trials were made by using the oil for firing a steam boiler in a manufacturing plant in New York, and as the boiler was one of a battery which was also tested for results with coal firing, the data and results are of comparative value.

The boiler was of the ordinary return tubular type of about 1,000 square feet of heating surface, and was arranged for use with oil fuel by covering the grate bars with fire-brick, a checker work being built up on the back portion of the grate. The air was admitted through ducts of hollow tile, coming in through the ash pit front and delivered back at the bridge wall, and then coming front and passing up in front of the grate bars and passing back with the burning oil through the checker-work and so under the boiler and back through the tubes. The oil burners were placed in front of each of the two fire doors, the oil being blown in by steam jets, and a portion of the air supply also being drawn in at these points; the mixture of steam, oil, and heated air being delivered into the furnace and meeting the main current of air flowing up from the ash pit. The boiler was operated from its normal capacity of 112 horse power to an over load of 220 horse-power, and the combustion appeared to be excellent, but little smoke being produced, even under the latter conditions.

The data and results of the tests are fully tabulated in the report, which is published in full in several of the technical journals, but some of the salient points may be mentioned here.

For a range of from 112 to 220 horsepower the total evaporation from and at 212° per pound of oil varied from 15.71 to 15.29 pounds of dry steam, and the burner consumption varied from 3.1 to 4.8 per cent. of the boiler output, so that the net evaporation ranged from 14.74 to 15.16 pounds of water per pound of oil.

The combustion of the oil by the burner was practically perfect, since by the evidence of the heat balance the heat accounted for by the steam production, the hot gases flowing to the chimney, and a reasonable allowance for radiation represents about 98 per cent. of the total heat of combustion of the oil when burned in oxygen in a calorimeter.

The boiler utilized about 78 per cent. of the heat of the fuel, which represents the best average boiler practice and the percentage of steam consumed by the burners is a minimum for steam-jet burners.

An excess of cold air probably caused a loss of evaporation for the smaller horsepower, but for the 189 and 220 horse-power tests there was no excess of the air necessary for complete combustion. Consequently for the two higher horse-powers the net evaporation of 14.8 pounds of water per pound of oil may be considered to represent the best economy that is to be expected from the use of the oil as a fuel with steam-jet burners.

The evaporation from and at 212° per pound of coal was 9.17 and 8.94 pounds of water for 93 and 119 horse-power. The coal afforded 11.6 per cent. of ash, and 14,680 B. T. U. per pound of combustible when burned in oxygen in a calorimeter, which represents an excellent No. 1 buckwheat. Considering that the coal was laden with 6.2 per cent. of moisture, and was consumed in the furnace to about 17 per cent. of ash, the evaporative results per pound of wet fuel are excellent. They correspond to an evaporation of 11.79 pounds from and at 212° per pound of combustible, which affords the very excellent boiler efficiency of 77.6 per cent.

We see therefore that the ratio of oil fuel to coal by weight for equal evaporation is 1.65 in favor of oil, 4.23 barrels of oil being the fuel equivalent of a ton of coal of 2,240 pounds.

The National Bureau of Standards.

A NATIONAL bureau of standards is by no means a new idea in the United States, but it is only recently that the project, which formed the subject of a report by Thomas Jefferson, when first Secretary of State, has taken definite form. In a paper in a recent issue of the *Journal of the Franklin Institute,* the Director of the Bureau, Mr. Samuel W. Stratton, gives an account of the newly established bureau at Washington, and outlines its projected work.

"According to the law enacted a year ago, the functions of the National Bureau of Standards include the custody of the official standards, and comparison of all standards used in scientific investigations, engineering, manufactures, commerce, and in educational institutions, with the standards adopted or recognized by the government, the construction, when necessary of standards, their multiples and submultiples, the testing of standard measuring apparatus, and the solution of problems which arise in connection with standards. It is also authorized to make physical and chemical researches for the purpose of determining physical constants, and the properties of materials when such data are of great importance to scientific or manufacturing interests. The Bureau is authorized to exercise its functions for the departments of the Government, for any State or municipality within the United States, scientific society, educational institution, firm, corporation, or individual engaged in manufacturing or other pursuits requiring the use of standards, or standard measuring instruments.

"A suitable site has been purchased by the Government adjacent to the picturesque national reservation known as Rock Creek Park in the northern suburbs of Washington, a locality free from mechanical and electrical disturbances. Plans are being prepared for a physical laboratory which will be equipped with apparatus and conveniences for carrying on investigations and testing standards and measuring instruments of all kinds, and a smaller building to be known as a mechanical laboratory which will contain the power and general electrical machinery, the instrument shop, refrigerating plant, storage batteries, dynamos for experimental purposes, and laboratories for electrical measurements requiring heavy currents.

"These laboratories will be constructed immediately, but the plans are being made with reference to the future growth of the Bureau, which will soon become one of the most important scientific institutions of our Government. The plans will include at least four buildings in addition to those now provided for.

"The scientific work of the Bureau will be under the immediate supervision of a director, assisted by a corps of physicists and chemists designated as laboratory assistants, assistant physicists or chemists, and physicists or chemists with salaries ranging from $1,000 to $5,000. These salaries are somewhat more liberal than the Government has hitherto paid the scientific men in its employ. These men have been carefully selected by civil service examinations prepared with reference to the kind of work to be undertaken. No attempt has been made by politicians or others to influence the appointments in the Bureau, and the Bureau once established upon this basis, will, it is believed be free from political influence.

"The value of such an institution has been clearly demonstrated by nearly every government in Europe. England has established a standards department of the Board of Trade, also the electrical standardizing laboratory, and recently a physical laboratory; Kew observatory, an institution famous for its testing of meteorological instruments, has also become a Government institution. Germany has established the Normal Aichungs Commission, with its laboratories and facilities for handling commercial weights and measures, and in 1887, the Physikalisch-Technische Reichsantalt, an institution costing more than a million dollars, which makes provision for scientific standards and investigations. It has been frequently said that this institution more than pays for itself annually in the assistance it gives to German manufacturers and scientists. The scientific work of our own Government has received great benefit from this institution during recent years. At the hearing before the House Committee on Coinage, Weights and Measures in reference to the Bureau of Standards Bill, the Secretary of the Treasury presented letters from every scientific bureau in the Government, stating that they were compelled to go to this institution for certain standards. It was this fact, coupled with statements to the same effect from the prominent manufacturers, scientists and others present at the hearing, that led the committee to report unanimously in favor of the bill establishing the bureau. There is scarcely an interest in the country which will not be vitally benefited by this new institution. Its relation to foreign commerce will be far-reaching, and its establishment means that the United States has taken a long step forward in the international race for commercial supremacy."

Director Stratton calls attention to the opportunity which the establishment of this bureau offers for the introduction of the metric system in the United States. In any event the introduction of a decimal system of weights and measures is regarded as most important, and the universal adoption of the metric system upon the continent of Europe, and its probable adoption in Great Britain, render it desirable that its defects be overlooked, and that it be adopted in the United States for the urgent commercial reasons which have been presented.

In any case the establishment of a national bureau of standards will go far towards the general introduction of standard methods of measurement, the use of standard gauges, and the adoption of methods of interchangeable production. Much useless expense will be avoided, increased output will follow, and the position of the United States in the struggle for commercial supremacy will be materially strengthened.,

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Electrical Illumination.

"If b-- some new invention the energy required to produce one candle-power in illuminants of all classes could be cut down to one-half its present value, the world would be in an uproar over it. But it is well within the truth to say that skilfully treated illumination will effect at least an equivalent saving, or will give vastly better results for the same expenditure of energy. Highly efficient radiants are *per se* very desirable, but if efficiency is gained at the loss of other important qualities, it may be dearly bought. Illumination, visual usefulness, is the thing to be sought."

These words give the key-note of Dr. Louis Bell's paper on "Methods of Illumination," with which he opened a topical discussion on "Methods of Illumination and Units of Light" at a recent meeting of the American Institute of Electrical Engineers. He discussed "the art of illumination from its human and practical side rather than the technical details of electric lighting, and compared methods as bearing upon the result rather than in their theoretical relations.

"Whatever the methods employed the end of artificial lighting should be to furnish illumination in quantity fully adequate for the conditions to be met, and in quality such as will neither unduly strain the eye nor in any way inconvenience the user. The three most important qualities for a practical illuminant are, in the order of their importance, as follows: 1. Steadiness. 2. Suitable intrinsic brilliancy. 3. Suitable color."

Dr. Bell thinks that "any source of light subject to rapid and frequent variations as great as five per cent. is unfit for use as an illuminant for work requiring steady use of the eyes. Much greater changes, occuring slowly enough for the iris to act with them, or at infrequent intervals, can be tolerated without inconvenience.

"Experience indicates that for radiants within the field of vision at the distances ordinarily met with in interior lighting an intrinsic brilliancy of five candle-power per square inch is about as high as it is wise for hygienic reason to go, and better rather less than rather more. This indicates at once for the radiants in common use that they should never be employed within the working field of vision without diffusing shields to keep down the intrinsic brilliancy.

"It is not necessary that artificial illuminants should conform to a particular color standard, save where color is a matter of prime importance. It is, however, true that the general applicability of a light is very strongly influenced by its hue, and that, broadly, strongly colored lights would fail conspicuously in visual usefulness.

"As regards artificial lights, generally supposed to fail conspicuously in giving what we are pleased to call "natural" color effects, every one of them, except the enclosed arc, which is strongly bluish, and the Welsbach, which is greenish, can be matched by normal sunlight at some time of the day. Even a Hefner lamp is not redder than a low sun on a hazy day. The ideal artificial light from a purely utilitarian standpoint should represent average sunlight, and as far as color is concerned, one can plan for artificial illumination with reasonable freedom of choice.

"As electrical engineers in dealing with problems of illumination we practically make use of the following classes of illuminants: Open arcs, enclosed arcs and incandescent lamps of various types and efficiencies, to which we must now add the 'Nernst' type of lamp. They vary widely in total power, in intrinsic brilliancy, in steadiness, in color and in efficiency, and all of these properties have to be borne in mind in adapting them to practical business."

Dr. Bell spoke of the benefit to be derived from even very simple reflectors, and showed a table giving photometric results with various types.

Mr. Peter Cooper-Hewitt read a paper on his mercury vapor lamps, which were used for lighting the meeting hall, and which have already been described in these columns; and there were other papers on street illumination, the incandescent lamp of to-day and standards of light.

One of the points brought out in the discussion was that arc lamps give fairly well distributed illumination in city streets, owing to the reflection from house walls, but that on country roads they are mere points of brilliancy in the darkness, wasting their brightness on the desert air, and that here incandescent lamps or even oil lamps might be better as far as visual usefulness is concerned.

All the papers contained matter of practical interest, but the limits of space prevent more than a bare mention of them.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCES IS THE ENGINEERING INDEX"

The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title, (2) The name of its author,
(3) A descriptive abstract, (4) Its length in words,
(5) When published, (6) Where published.
We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Great Stone Bridges in the Grand Duchy of Baden (Grosse Steinbrücken im Grossherzogtum Baden). R. Moser. A well illustrated description of two fine stone arches, with spans of 64 meters and 57 meters, respectively, on a railway in Southern Germany. 4000 w. Schweiz Bauzeitung—Dec. 21, 1901. No. 45838 B.

The Determination of the Thrust in Masonry Arches (La Determination de la Poussée dans les Voûtes en Maçonnerie). M. Auric. Deducing formulas for the computation of the thrust for arches of various dimensions and loadings. 6000 w. Ann des Ponts et Chaussées—2 Trimestre, 1901. No. 45817 E+F.

Brooklyn Bridge.

The Condition of the Brooklyn Bridge. Extracts from the Annual Report of the Commissioner of Bridges, from the special report of Messrs. Buck and La Chicotte. 6200 w. R R Gaz—Jan. 10, 1902. No. 45481.

The Official Report of the Condition of the Brooklyn Bridge. Editorial review of this report. 3200 w. Eng Rec—Jan. 4, 1902. No. 45340.

I. The Physical Condition and Safety Under Present Loads of the New York and Brooklyn Bridge. Gus C. Henning. II. Mr. Hildenbrand's Reply to the Report of Messrs. Duryea and Mayer on the New York and Brooklyn Bridge. Mr. Henning's letter is also a discussion of this same report. 17000 w. Eng News—Jan. 16, 1902. No. 45486.

Comparison.

Suspension and Cantilever Bridges. A discussion and comparison of these types, with remarks on the arch type. 2300 w. Engr, Lond—Jan. 17, 1902. No. 45780 A.

Concrete Arch.

A Three-Hinged Concrete Arch Bridge Over the Danube at Ehingen. Illustrates and describes this engineering work which possesses points of interest. 1400 w. Eng News—Jan. 9, 1902. No. 45370.

Concrete Bridge on the Gürbethal Railway, Switzerland (Betonbrücke der Gürbethalbahn). R. Moser. Illustrated description of a concrete arch, 23.4 meters span, for single track, near Bern. 600 w. Schweiz Bauzeitung—Dec. 14, 1901. No. 45836 B.

Draw-Bridges.

A Graphical Method for the Solution of Stresses in the Continuous Girder, as Applied to Draw-Bridges. Discussion of the paper by George F. Barton. 2000 w. Pro Am Soc of Civ Engrs—Dec., 1901. No. 45217 E.

The Little Calumet River Drawbridge. Illustrated detailed description of a double-track, through plate-girder drawbridge of 171 1/3 ft. span, in Illinois. 2000 w. Eng Rec—Dec. 28, 1901. No. 45229.

East River Bridge.

The New East River Bridge. Illustrations showing the present condition of the New East River Bridge at New York, with comments. 1200 w. Ir Age—Jan. 2, 1902. No. 45244.

Girders.

Erection of Girder Spans on the West Virginia Short Line R. R. Illustrates and describes some of the work on the West Virginia Short Line Railroad, a single-track line recently built to develop rich coal and oil resources. It is 60 miles in length and has 54 steel bridges and 3 tunnels. 4000 w. Eng Rec—Jan. 18, 1902. No. 45712.

Highway Bridges.

The Chippewa Falls Highway Bridge. Illustrated detailed description of a new through riveted-truss highway bridge, built to replace a narrower bridge, without interruption of traffic. 1600 w. Eng Rec—Jan. 25, 1902. No. 45741.

The Middletown (Conn.) Bridge—The Longest Highway Draw Span. H. G. Tyrrell. Illustrates and describes the superstructure and substructure. 2500 w. R R Gaz—Dec. 27, 1901. No. 45234.

India.

The Railway Bridge Over the Godavari River at Rajahmundry, on the East Coast Railway in India. Two-page plate and other illustrations of a recently constructed bridge of 50-spans of 150 ft. each, its total length being 9096 ft. over all. Detailed description to appear later. Engng—Jan. 3, 1902. Serial. No. 45430A.

Laibach.

Reconstruction of the Laibach Moor Bridge on the Southern Railway of Austria (Umbau der Laibacher Moorbrücke der Südbahn). F. X. Gürke. A very completely illustrated description of this bridge and viaduct across swampy ground, with details of construction. Also a description of Prof. A. Belar's apparatus for recording bridge vibrations. 3 plates. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 27, 1901. No. 45697 B.

Lift Bridge.

A New Scherzer Rolling Lift Bridge at Cleveland. Illustrates and describes a recent bridge over the Cuyahoga River, built to replace a swing bridge, because of navigation interests. 900 w. R R Gaz—Jan. 17, 1902. No. 45537.

Prague.

The Temporary Bridge over Hetz Island at Prague, Bohemia (Die Provisorische Brücke über die Hetzinsel in Prag). Rudolf Kaplan. A well illustrated description of the design and construction of a provisional bridge over the Moldau River. 1 plate. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 14, 1901. No. 45691 B.

Replacement.

Chicago, Milwaukee & St. Paul Bridge at Minneapolis. Illustrated description of an important piece of replacement work over the Mississippi River. 800 w. Ry Age—Jan. 3, 1902. No. 45363.

Strain Recorder.

Apparatus for Recording the Local Deformation of Metal Pieces (Appareil Enregistreur de la Déformation Locale des Piéces Métallique). MM. Schroeder, Vander Kolk, & Kist. Illustrating and describing various devices for attachment to members of a bridge or other framed structure, to record the deflections under actual loads. 2000 w. Ann des Ponts et Chaussées—2 Trimestre, 1901. No. 45814 E+F.

Stringers.

Experimental Examination of the Stringers of Railway Bridges (Enquète Experimentale sur les Longerons des Ponts). N. C. Kist. A report of tests upon the bridges of the Netherlands State Railways with reference to certain breakages in the longitudinal members supporting the rails. 5000 w, 1 plate. Ann des Ponts et Chaussèes—2 Trimestre, 1901. No. 45815 E+F.

Swing-Bridge.

Opening Bridge Over the Flood-Course at Winnington. Illustrated description of a recently constructed bridge operated by electric power. 600 w. Engng—Dec. 27, 1901. No. 45294 A.

Viaducts.

Arched Viaduct Over the Seine, Paris. Illustrates the viaduct for joining the Gare St. Lazare to the Champ de Mars and to the Invalides Railway Station. Description and further illustrations to appear later. 2-page plate. 200 w. Engng—Jan. 17, 1902. Serial. 1st part. No. 45775 A.

Concrete Steel Details of French Viaducts. Brief illustrated descriptions of brackets and parapets, as given in *Genie Civil.* 350 w. Eng Rec—Dec. 28, 1901. No. 45226.

The New Kinzua Viaduct (Der Neue Kinzua-Viaduct in Nordamerika). Hr. Frahm. A well illustrated description of the new viaduct, with a short history of the old one. 3500 w. Stahl u Eisen—Jan. 1, 1902. No. 45639 D.

CANALS, RIVERS AND HARBORS.

Bank Protection.

The Serrazanetti System of Protective Works for the Banks of Rivers and Brooks (Das System Serrazanetti zur Herstellung von Schutzbauten an Flüssen und Bächen). An illustrated description of a system using wire netting gabions, which has been successfully employed in Italy. 2500 w. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 14, 1901. No. 45689 B.

Canal Lift.

Electric Ship's Lift at Henrichenburg. Illustrated description of a ship's lift in which a large tank 230 ft. long, 28 ft. wide, and 8 ft. deep, having sufficient water-carrying capacity and space to float canal vessels up to 800 tons displacement, is moved up and down from one level to the other. 2500 w. Engr, Lond—Jan. 3, 1902. No. 45437 A.

Canal Navigation.

Some Important Phases of Canal Navigation, Illustrated by Recent Experiments in Germany. Elnathan Sweet. A consideration of the experiments of Herr R. Haack, in Germany, and the knowledge they give of the negative velocities produced in canal navigation, and the limited rate of dirigible speed. 2800 w. Pro Am Soc of Civ Engrs—Dec., 1901. No. 45213E.

Cosel.

The Harbor of Cosel on the Oder, Silesia (Ueber den Oderhafen bei Cosel). Josef Riedel. An illustrated description of this harbor and docks with statistics of costs and traffic. 1 plate. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 7, 1901. No. 45685 B.

Dredge.

Marine Suction Dredge (Drague Marine Porteuse à Succion et à Refoulement). An illustrated description of a sea-going dredging vessel, built by L. Smit and Son, Holland. 1 plate. 1800 w. Génie Civil—Jan. 4, 1902. No. 45662 D.

Dry Dock.

A New Dry Dock at Baltimore, Md. Illustrated description of one of the largest dry docks in the United States, capable of docking a vessel of 600 ft. in length and 70 ft. beam, with a draft of 22½ ft. 1300 w. Eng News—Jan. 9, 1902. No. 45371.

Elbe-Kiel.

The Proposed Elbe-Kiel Canal (Das Project eines Elbe-Kielcanals). Josef Riedel. A review of the project of Hr. August Sartori for a canal between the port of Kiel, on the Baltic, and the Elbe River, at Lauenburg, with map and profile. 1 plate. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 28, 1901. No. 45695 B.

Flood Prediction.

The Prediction of the Height of Water in the Elbe and Moldau Rivers in Bohemia (Die Wasserstandsvoraussagen an der Elbe und Moldau in Böhmen). An account of the work of the Austrian Hydrographic Office in observing river levels and giving warning of floods, with tables and diagrams. 2 plates. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 7, 1901. No. 45688 B.

Holland.

The North-Sea Canal, the Ymuiden Locks, and the Port of Amsterdam. Illustrated description of the engineering work that has made the city of Amsterdam a sea-port. 3200 w. Engng—Jan. 10, 1902. Serial. 1st part. No. 45545 A.

Isthmian Canal.

A Comparison of the Panama and Nicaragua Canal Routes. A general description, with map and diagram, showing the advantages of one route over the other. Also editorials. 5000 w. Sci Am—Jan. 18, 1902. No. 45516.

The Canal Across the Isthmus. Editorial discussion of the routes. 1600 w. R R Gaz—Jan. 3, 1902. No. 45352.

The Isthmian Canal Commission's Explanation of its Choice of Dimensions for the Isthmian Canal. Ill. 1200 w. Eng Rec—Jan. 18, 1902. No. 45714.

The Isthmian Canal Controversy. Two complete articles on the Panama and Nicaragua routes based upon the reports of the International Commission on Panama and of the Nicaragua Canal Commission, with digest of the report just issued, and many illustrations. 14700 w. Sci Am Sup—Jan. 18, 1902. No. 45519.

The Panama Canal Route. Editorial on the changed conditions due to the recent offer of the French company and the present position of the undertaking. 1200 w. Eng Rec—Jan. 25, 1902. No. 45739.

The Report of the Isthmian Canal Commission. Editorial review of the questions as to whether the canal will pay, the risks due to earthquakes and climate, and dimensions and unit prices. 2500 w. Eng News—Jan. 2, 1902. No. 45347.

Land Reclamation.

The St. Francis Levee Districts of Arkansas and Missouri. Harry N. Pharr. An interesting account, with maps, of the important engineering work now in progress for reclaiming the land of this basin. 5000 w. Eng News—Jan. 9, 1902. No. 45367.

Maritime Works.

Zeebrugge Harbor Works. M. J. Nyssens Hart and M. L. Van Gansberghe. Read before the Glasgow Congress. Illustrates and describes the breakwater construction at this port on the Belgian Coast. 2400 w. Engng—Jan. 10, 1902. No. 45549 A.

Nile.

Irrigation in the Nile Valley (Die Bewässerung im Nillande). From reports of the Austrian consul at Cairo, giving a general account of the subject with mention of the works at Assouan and Assiout. 1000 w. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 7, 1901. No. 45687 B.

Prague.

The Raft Harbor at Prague-Smichov (Le Port de Flottage de Prague-Smichov). M. Hromas. Describing the harbor for the timber rafts brought down the Moldau from the forests of Bohemia. 3000 w. Ann des Ponts et Chaussées—2 Trimestre, 1901. No. 45818 E+F.

Review.

Harbors and Waterways in 1901. A review of works completed, in progress and proposed. 4300 w. Engr, Lond—Jan. 3, 1902. No. 45434 A.

River Improvements.

The Mouth of the Danube. C. H. Kühl. Read before the Glasgow Congress. Describes recent improvements effected in the navigable condition of the Sulina branch and outlet of the Danube. Chart. 4200 w. Engng—Dec. 27, 1901. No. 45296 A.

River Regulation.

River Regulating Works (Les Travaux de Régularisation et le Régimè des Rivières). L. L. Vauthier. Discussing especially improvement works for the control of inundations. Paper at the VIII Congress of Navigation. 12000 w. Ann des Ponts et Chaussées—2 Trimestre, 1901. No. 45812 E+F.

Ship Railway.

Panama Ship Railway (Panama ou Nicaragua). An article strongly advocating a ship railway at Panama, as proposed by M. Amadée Sébillot, and giving a plan and estimates for one. 5000 w. Revue Technique—Dec. 25, 1901. No. 45671 D.

Zuider Zee.

The Closing up and Drainage of the Zuider Zee (Abschliessung und Trockenlegung der Zuidersee). A general account of this proposed undertaking, with estimate of the cost. Map. 1800 w. Oesterr Wochenschr f d Oeffent Baudienst—Nov. 30, 1901. No. 45681 B.

CONSTRUCTION.

Building Details.

Structural Features of the Frick Building, Pittsburg. Illustrates and describes the construction of a twenty-story steel-cage fireproof office building. 3900 w. Eng Rec—Jan. 11, 1902. No. 45478.

Dams.

A General Review of the Discussion on Proposed Changes in the New Croton Dam. A letter from Alfred Craven, with illustrations. 3000 w. Eng News—Jan. 9, 1902. No. 45369.

A Rock-Fill Dam with Steel Core Across East Canyon Creek, Utah. W. P. Hardesty. Illustrated description of this work, with comments on country irrigated. 3500 w. Eng News—Jan. 2, 1902. No. 45348.

Chief Engineer Hill's Report on Proposed Changes in the New Croton Dam and Jerome Park Reservoir. Official report of William R. Hill. Ill. Also A Special Report of Changes in the Jerome Park Reservoir, by Edwin F. Smith. 8000 w. Eng News—Jan. 16, 1902. No. 45484.

The Benton Mills Dam, Mariposa County, Cal. Diagrams, illustrations and description of the method of construction. 1000 w. Min & Sci Pr—Jan. 18, 1902. No. 45583.

The Bohio Dam. George S. Morison. Concerning the dam by which the summit level must be maintained on the route of the Panama Canal, describing the formation of the country and the engineering difficulties, and discussing three methods of taking care of the Chagres floods while the dam is building. Ill. 6500 w. Pro Am Soc of Civ Engrs—Jan., 1902. No. 45748 E.

Dome.

The Dome of the Reichstags Building in Berlin (Die Kuppel des Reichstagshauses in Berlin). A discussion between H. Zimmermann and Hr. Zschetzsche about the design of this dome, with diagrams and formulæ. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 27, 1901. No. 45699 B.

Educational Buildings.

The Centenary Collegiate Institute, Hackettstown, N. J. Gives the first-floor plans of interesting new buildings, with information concerning them. 1200 w. Eng Rec—Dec. 28, 1901. No. 45232.

Elevator.

The Weehawken Elevator. Illustrated description of a fireproof grain elevator of 2,000,000 bushels total capacity, being built at Pier 7, Hudson River. 3600 w. Eng Rec—Dec. 28, 1901. No. 45230.

Foundations.

The Foundation of the Port Richmond Grain Elevator. Illustrated description of crib and foundation work near Philadelphia. 1000 w. Eng Rec—Jan. 18, 1902. No. 45719.

Grain Storage.

See Mechanical Engineering, Miscellany.

Piles.

The Supporting Power of Piles. Ernest P. Goodrich. A discussion of the use of the common, tapering, round, wooden pile, driven by the ordinary gravity hammer, and held simply by the contact of the surrounding soil. Ill. 7500 w. Pro Am Soc of Civ Engrs—Dec., 1901. No. 45214 E.

Retaining Walls.

The Graphical Determination of Retaining Wall Surfaces (Graphische Ermittelung der Flächen von Stützmauer-Profilen). Karl Lechner. An illustrated description of graphical methods in retaining wall calculations. 2 plates. 800 w. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 28, 1901. No. 45696 B.

Roads.

Making Roads by Machinery. Waldon Fawcett. Illustrated description of special apparatus employed in road making, with an account of the government investigations of the Office of Road Inquiry of the Department of Agriculture. 1500 w. Sci Am—Jan. 11, 1901. No. 45381.

The State Roads of Massachusetts. Extract from a paper by Albert S. Merrill in *The Municipality.* Concerning the work of the Highway Commission. 2400 w. Eng Rec—Jan. 11, 1902. No. 45477.

Steel Construction.

Notes on Iron and Steel Construction. M. M. Sloan. The first of a series of articles aiming to give reliable and working data upon this subject. 2800 w. Am Archt—Jan. 4, 1902. Serial. 1st part. No. 45353.

The Steel Framing of the General Electric Foundry, Schnectady. Illustrates and describes particulars of the structural details. 1100 w. Eng Rec—Jan. 18, 1902. No. 45718.

Structural Work.

Colonial Structural Work. An examination of the present position of affairs in England, in an endeavor to discover why colonial trade is given to foreign countries. 4400 w. Engr, Lond—Dec. 20, 1901. No. 45279 A.

Tunnels.

Methods of Work on the East Boston Tunnel Extension of the Boston Subway. Account of the work extracted from the report of Chief Engineer Howard A. Carson. Ill. 4300 w. Eng News—Jan. 23, 1902. No. 45732.

Progress on the East Boston Subway and Tunnel. Illustrated description of the construction work on the branch extension of the Boston subway into East Boston. 2500 w. Ry & Engng Rev—Jan. 11, 1902. No. 45470.

Work on the East Boston Tunnel. From the official progress report of Mr. Howard A. Carson. 2300 w. Eng Rec—Jan. 11, 1902. No. 45475.

Test Borings in the Bed of the East River, New York. An account of the subaqueous boring between Manhattan and Brooklyn on the line of the proposed Rapid Transit tunnel. 1000 w. Eng Rec—Jan. 18, 1902. No. 45713.

The Location and Construction of Railway Tunnels. Extracts from a paper by Mr. Arthur E. Rogers, published by the Inst. of Civ. Engrs. Discusses the materials to be tunneled, estimating, &c., giving examples of several tunnels where unusual conditions were met, and methods used. 4000 w. Eng Rec—Jan. 18, 1902. No. 45717.

The Simplon Tunnel (Traforo del Sempione). A Ferrucci. A discussion of the progress up to the close of 1901, and an account of the irruption of water on the Italian side. 1000 w. Gior d Lav Pubb e delle Str Ferr—Jan. 15, 1902. No. 45808 D.

Underpinning.

Underpinning an Unfinished Steel-Cage Building. Illustrated description of an interesting piece of engineering work. An unfinished building thrown out of plumb by adjacent excavations, is restored to a safe condition and foundations built. 1000 w. Eng Rec—Jan. 25, 1902. No. 45745.

Warehouse.

A Brick Warehouse Building at Columbus, Ohio. Describes the construction of a 166 x 62-ft. five-story and basement, slow-burning warehouse, costing about $85,000. 1500 w. Eng Rec—Dec. 28, 1901. No. 45231.

MATERIALS.

Cement.

Action of Sulphate of Lime on Cement (Action du Sulfate de Chaux sur les Ciments). L. Deval. A record of experiments with various cements. 1000 w. Bull Soc d'Encour—Dec., 1901. No. 45679 G.

Slag Cement Manufacture in Alabama. Edwin C. Eckel. Description of two slag cement plants now operating near Birmingham, Ala. 1400 w. Eng News—Jan. 23, 1902. No. 45728.

Some Comparisons of Standard Specifications for Testing Portland Cement. E. Duryee. A comparison of the Russian specifications with the American, German, and French rules. 2200 w. Eng News—Jan. 9, 1902. No. 45366.

The Chemical Analysis of Portland Cement. Richard K. Meade. On the value of chemical analysis, what it shows, &c. 800 w. Min & Sci Pr—Jan. 4, 1902. No. 45377.

The Determination of the Soundness of Portland Cement. Translated report of the Committee of the Soc. of German Portland Cement Mfrs. 600 w. Eng Rec—Jan. 18, 1902. No. 45716.

The History, Manufacture, Testing, and Uses of Portland Cement. H. Howard Humphreys. Reviews the history, describes the principal methods of manufacture and testing, and much information of interest. Also discussion. 17700 w. Builder—Dec. 28, 1901. No. 45265 A.

Uniformity of Analysis in the Portland Cement Industry. Describes the method of analysis formulated by the Committee of the Society of Chemical Industry. 1700 w. Eng Rec—Dec. 28, 1901. No. 45228.

Concrete.

The Coefficient of Expansion of Concrete. William D. Pence. Describes the scope and method of investigations made, giving results of tests. General discussion. 12500 w. Jour W Soc of Engrs—Dec., 1901. No. 45308 D.

Flexure.

The Computation of the Flexure of Rectangular Plates (Le Calcul des Piéces Rectangulaires Fléchies). A. Mesnager. An application of the elastic theory to plates and thin beams, deducing the fundamental equations. 2500 w. Ann des Ponts et Chaussées—2 Trimestre, 1901. No. 45813 E+F.

Reinforced Concrete.

Breaking Test of a Reinforced-Concrete Beam (Epreuve j'usqua la Rupture d'une Poutre en Ciment Armé). N. de Tedesco. An illustrated account of tests of reinforced concrete for an infantry barracks at Gorinchem, Holland. 1200 w. Revue Technique—Dec. 10, 1901. No. 45667 D.

Canal Facing in Reinforced Concrete (Revêtement en Béton de Ciment Armé). MM. Barbet & Hausser. A description of the use of reinforced concrete on the Canal de l'Est, at Epinal, with details of the computations. 3500 w. 1 plate. Ann des Ponts et Chaussées—2 Trimestre, 1901. No. 45818 E+F.

Concrete and Brick Construction with Continuous Interwoven Metallic Cores. H. E. P. Cottrell. Illustrated description of a construction which introduces into concrete and brick structures a series of thin rods or bars, which are carried from foundations to roofs, stating the advantages claimed. Also describes works built on this system. 2800 w. Builder—Jan. 11, 1902. No. 45512 A.

Practical Applications of Reinforced Concrete. Jacques Boyer. Prof. Boyer's second article discusses the materials, methods and industrial applications of concrete-steel construction, with numerous illustrations. 4000 w. Engineering Magazine—Feb., 1902. No. 45821 B.

Slate.

The Green Slates of the Lake District. T. Mellard Reade and Philip Holland. A study of these roofing slates of the English Lake District. Describes specimens examined. Ill. 6000 w. Quarry—Jan. 1, 1902. No. 45508 A.

Timber.

Protecting Timber from Natural Enemies. George Ethelbert Walsh. On the destruction caused by insects and timber-destroying fungi. 2200 w. Archts & Builds Mag—Jan., 1902. No. 45300 C.

The Behavior of Impregnated Wooden Poles of the Austrian Government Telegraph Department (Uber das Verhalten Imprägnierter Holzsäulen im Gebiete der Staats-Telegraphen-Verwaltung). Robert Nowotny. An account of experience with telegraph and telephone poles treated with various preservatives. 2500 w. Oesterr Wochenschr f d Oeffent Baudienst—Nov. 30, 1901. No. 45683 B.

MEASUREMENT.

Hydrography.

The Steamer "Hydrographer." Illustrated description of the latest addition to the surveying vessels of the U. S. Coast and Geodetic Survey. 800 w. Marine Engng—Jan., 1902. No. 45251 C.

Meridian.

The Location of a Meridian by Polar Elevation (Le Tracé d'une Méridienne par une Hauteur de la Polaire). M. Dehalu. Describing a method adapted for use with the surveyor's theodolite, and suitable for topographical surveying. 2000 w. Rev Univ des Mines—Dec., 1901. No. 45803 H.

Metric System.

The Metric Convention and the International Bureau of Weights and Measures (La Convention du Mètre et le Bureau International des Poids et Mesures). C. E. Guillaume. M. Guillaume's fourth paper treats of the last expansion of solids, particularly different nickel-steel alloys. Curves and tables. 3500 w. Bull Soc d'Encour—Dec., 1901. No. 45676 G.

Surveying.

Some Devices for Increasing the Accuracy or Rapidity of Surveying Operations. Walter Loring Webb. Illustrates and describes devices designed under the direction of the writer. All have been subjected to practical use. 2400 w. Pro Am Soc of Civ Engrs—Dec., 1901. No. 45215 E.

Surveys for the Manhattan Queens Bridge, New York. An account of the method of conducting the surveys, as described in the chief engineer's report. The bridge passes over Blackwell's Island. 1200 w. Eng Rec—Jan. 25, 1902. No. 45742.

The Mining Meridianoscope (Le Méridianoscope Minier). Ch. Monkowski. Describing a form of solar compass adapted for geological surveying in localities in which the presence of iron ore deposits affect the magnetic needle. 1800 w. 1 plate. Rev Univ des Mines—Dec., 1901. No. 45804 H.

MUNICIPAL.

Boulevard.

The Grant Boulevard, Pittsburg. John Brunner. Describes the construction of a boulevard 15,407 feet long and 60 feet wide, between the business and residence sections of the city. 1300 w. Eng Rec—Jan. 18, 1902. No. 45715.

Consolidation.

A Combination Public Service Plant. Illustrates and describes a successful example of consolidation of public water, gas and electricity supply at Franklin, Indiana. 1600 w. Elec Rev, N. Y—Jan. 4, 1902. No. 45401.

Drainage.

Drainage of the Cemetery at Saaz, Bohemia (Entwässerung des Friedhofes in Saaz). Friedrich Krivanec. An illustrated description of the work and of the drains and underground conduits. 1 plate. 1200 w. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 21, 1901. No. 45693 B.

The Aramingo Drainage System, Philadelphia. George E. Datesman. States the problem presented and gives and an illustrated description of the work. 3000 w. Eng Rec—Dec. 28, 1901. No. 45227.

Garbage.

Garbage Collection, Removal, and Final Disposal at Milwaukee, Wis. Illustrates and describes the new municipal garbage crematory, with notes on the history of garbage disposal at Milwaukee, containing useful lessons. 5000 w. Eng News—Jan. 23, 1902. No. 45729.

Pavements.

Bituminous Macadam Pavement. Extracts from a paper by Fred J. Warren, before the Boston Soc. of Civ. Engrs. stating the principles upon which this type of pavement is based; and also a summarized statement of some of the work. 3800 w. Eng Rec—Jan. 25, 1902. No. 45744.

Septic Tanks.

Experimental Septic Tanks at Ithaca, N. Y. Facts from a thesis by R. B. Williams, Jr., concerning the principles governing the septic-tank method of sewage disposal. Ill. 2500 w. Eng Rec—Jan. 11, 1902. No. 45476.

Sewage Disposal.

The Bayer System of Sewage Disposal (Abwasserreinigung, System Alexander Bayer). Abstract of a paper before the Oesterr. Ing. und Architekten Verein, giving a description of a system for purifying sewage and factory and slaughter house wastes, and utilizing many of the products. 1 plate. 7000 w. Oesterr Wochenschr f d Oeffent Baudienst—Nov. 30, 1901. No. 45682 B.

The Development of Sewage Disposal during the Last Century. Charles Mason. Read before the British Soc. of Engrs. Reviews the various stages through which the theory and practice of sewage purification has passed during the last century. 1800 w. Dom Engng—Jan. 15, 1902. Serial. 1st part. No. 45579 C.

Sewerage and Sewage Disposal of Burton-upon-Trent. Jonah Walker Smith. A paper published by the Inst. of Civ. Engrs. A description of the work that has been carried out since 1883, describing the conditions previous to that time. The sewage is pumped to a farm and treated by broad irrigation and intermittent filtration. 4300 w. Eng Rec—Jan. 25, 1902. No. 45743.

Sewerage of the Passaic River Valley. Editorial discussing the methods of final disposal of the domestic and manufacturing sewage of this district proposed in the recently submitted report of Messrs. Herring, Croes, and Brown. 1500 w. Eng Rec—Dec. 28, 1901. No. 45224.

WATER SUPPLY.

England.

Water Affairs. An editorial review of the principal events of the past year in England. 5000 w. Jour Gas Lgt—Dec. 31, 1901. No. 45417 A.

Purification.

The Pittsburg Water Purification Works. Illustrated detailed description of new works to comprise a pumping station and a large slow-sand filtration plant. 4500 w. Eng Rec—Jan. 25, 1902. No. 45740.

Reservoir.

The Jerome Park Reservoir. Editorial discussion of the recent developments and reports concerning changes recommended. 1400 w. Eng Rec—Jan. 18, 1902. No. 45711.

Well Boring.

Deep Well Boring at the Bavaria Brewery in Altona (Tiefbrunnenbohrung in der Bavaria-Brauerei in Altona). Hr. Darapsky. An account of the difficulties met and overcome in boring 190 metres for water, near the mouth of the Elbe. 1200 w. Zeitschr d Ver Deutscher Ing—Dec. 21, 1902. No. 45602 D.

MISCELLANY.

Education.

The Education of an Engineer. T. Hudson Beare. Delivered before the students of the Univ. of Edinburgh, Glasgow, Scotland. Briefly describes the methods adopted in America, in Germany, and in England; stating also the writer's views. Gives an idea also of the great number being educated in technical colleges, and other information of interest. 5800 w. Naut Gaz—Jan. 16, 1902. No. 45503.

Hawaiian Islands.

Some Interesting Engineering Feats. John Ericson. Brief outline of the important works constructed in the Hawaiian Islands since their annexation to the United States. 1000 w. Mod Mach—Jan. 1902. No. 45446.

ELECTRICAL ENGINEERING

COMMUNICATION.

Belgium.

Telephones in Belgium. Describes the service, and notes the change from equal assessments to the message system. 1000 w. U S Cons Repts, No. 1240—Jan. 16, 1902. No. 45500 D.

Brazil.

Telegraph System of Brazil. A report of the telegraph lines, rates, and matters of interest in regard to their operation. 1700 w. U S Cons Repts, No. 1239—Jan. 15, 1902. No. 45409 D.

Cables.

Notes on the Cable Industry in Germany. Mervyn O'Gorman. Discusses German practice, concluding that it is not ahead of the English, but that seeds of important advance have been sown. 1100 w. Elec Rev, Lond—Jan. 17, 1902. No. 45766 A.

Construction.

Telephone Construction—City Work Plans. W. H. Johnson. This first article discusses present conditions, and the making of plans. 2800 w. Telephony—Dec., 1901. Serial. 1st part. No. 45399.

Exchanges.

Glasgow Corporation Telephone Exchange. Detailed illustrated description of a municipal telephone equipment. 3800 w. Elect'n, Lond—Dec. 20, 1901. Serial. 1st part. No. 45255 A.

The Construction of Small Telephone Exchanges. A. E. Dobbs. Discusses the advantages and disadvantages of party lines and gives suggestions for farmers' lines. 1800 w. Elec Rev, N. Y—Jan. 4, 1902. No. 45400.

Ventilation of a Telephone Exchange. Illustrated description of an interesting example of ventilating where the avoidance of drafts was difficult. 1400 w. Eng Rec—Jan. 11, 1902. No. 45479.

German Empire.

Telegraphy and Telephony in the German Empire (Telegraphen-und Fernsprechwesen im Deutschen Reichs-Postgebiet). Abstract of the official statistics for 1900. 1500 w. Elektrotech Zeitschr—Dec. 19, 1901. No. 45620 B.

High-Speed Telegraphy.

High-Speed Telegraphy (Rundschau). An editorial discussion of the advantages of and need for high-speed telegraphy and automatic apparatus, particularly in Germany. 1200 w. Elektrotech Zeitschr—Dec. 19, 1901. No. 45615 B.

Nomenclature.

The Origin of Telephonic Nomenclature. Harry S. Coyle. An explanation of the sources from which the terms used are derived. 1800 w. Telephony—Jan., 1902. No. 45591.

Poles.

The Passing of Telephone Poles. Thomas F. Gilroy. An illustrated article on the changes in New York city resulting from abolishing aerial wires. 1400 w. Am Tel Jour—Jan. 11, 1902. No. 45443.

See also Civil Engineering, Materials.

Printing Telegraph.

Applications and Requirements of a Printing Telegraph. Romyn Hitchcock, in the *Telegraph Age*. Presents reason why such an invention would never take the place of the Morse key in general telegraphic work, and discusses the lines where it would doubtless find use. 2000 w. Ry & Engng Rev—Jan. 11, 1902. No. 45471.

Relay System.

Power Plants for Relay Switchboards. A. A. Burch. Discusses the designing of a power plant for a relay system, the power supply, test of plant, care required, &c. 7500 w. Telephony—Feb., 1902. No. 45590.

Repeating Coils.

Something About Repeating Coils. A. E. Dobbs. An illustrated article giving information concerning coils used on long telephone lines. 1600 w. Am Tel Jour—Jan. 11, 1902. No. 45442.

Space Telegraphy.

Some Experiments with Wireless Telegraphy. Experiments made with the Armorl system are illustrated and described. 2000 w. Sci Am—Jan. 18, 1902. No. 45517.

Some Unconsidered Aspects of Wireless Telegraphy. Charles T. Child. Discusses considerations arising from Mr. Marconi's work and their results, and their practical utilization. 1100 w. Elec Rev, N. Y—Jan. 11, 1902. No. 45458.

The Slaby-Arco Portable Field Equipment for Wireless Telegraphy. A. Frederick Collins. An illustrated article discussing improvements made in this system. 2100 w. Sci Am—Dec. 28, 1901. No. 45221.

Wireless Telegraphy v. Submarine Cables. Discusses Mr. Marconi's recent experiments and his claim of having received a signal across the Atlantic; also its possible effect on the cable system, quoting from many authorities as to the outlook. 2000 w. Elec Rev, Lond—Jan. 17, 1902. Serial. 1st part. No. 45767 A.

Telephone Cable.

Measurements of Telephone Cables with Self Induction (Messungen an einem Fernsprechkabel mit Selbstinduktion). Dr. F. Breisig. An account of experiments with telephone conductors wound with iron wire to increase their inductance. 3000 w. Elektrotech Zeitschr—Dec. 19, 1901. No. 45619 B.

The Underground Telephone Network at Chaux-de-Fonds, Switzerland (Das Unterirdische Telephonnetz zu Chaux-de-Fonds). An illustrated description, abstracted from *Journal Telegraphique*, of a telephone distribution system. 1000 w. Elektrotech Zeitschr—Jan. 9, 1902. No. 45633 B.

Telephony.

Telephone Engineering. Franz J. Dommerque. The first of a series of articles devoted to the discussion of the building and maintenance of telephone plants and the operation of exchanges. 1400 w. Am Elect'n—Jan., 1902. Serial. 1st part. No. 45332.

The Bell Company's Central Energy System. W. S. Henry. An explanation, with diagrams, of the principles of the Hayes common battery system. 2500 w. Am Elect'n—Jan., 1902. No. 45335.

Testing.

Electrical Testing for Telephonists. H. S. Webb. Describes apparatus necessary where much testing is to be done, in addition to the ordinary magneto set. The present article describes galvanometers and shunts. 2500 w. Am Tel Jour—Jan. 25, 1902. Serial. 1st part. No. 45781.

Toll-Lines.

Rules and Specifications for the Construction of Telephone Toll Lines and Farmers' Circuits. W. H. Crumb. Ill. 5000 w. Telephony—Dec., 1901. No. 45398.

DISTRIBUTION.

Alternating Currents.

Power Factor in Alternating Current Circuits. Fred W. Ballard. An illustrated article discussing the effect of the power factor on the efficiency, and regulation, and describing a method for plotting the curves of current and electromotive force in alternating current circuits. 2500 w. Engr, U S A—Jan. 1, 1902. Special number. No. 45576 C.

The Induction Motor and the Rotary Converter and Their Relation to the Transmission System. Charles F. Scott. An examination of their behavior in service, indicating the characteristics which have made them so successful. 3500 w. Trans Am Inst of Elec Engrs—Dec., 1901. No. 45488 D.

The Theory and Calculations of Alternating-Current Transmission Lines.

Charles W. Startsman. A discussion aiming to point out the difficulties attending electric power transmission and to show how far they have been overcome. 3500 w. Elec Rev, N. Y—Dec. 28, 1901. No. 45237.

Booster.

A Method for Diminishing the Drop of Potential in Rails Carrying the Return Current (Ueber ein Neues Verfahren zur Verminderung des Schienenpotentialgefälles bei Elektrischen Bahnen mit Schienenrückleitung). Gisbert Kapp. A paper before the Elektrotechnische Verein, with diagrams, advocating the installation of booster dynamos at points along the railway, feeding into the rails. With discussion. 5000 w. Elektrotech Zeitschr—Jan. 2, 1902. No. 45630 B.

Electrical Systems.

Electrical Systems. John H. Ryan, Jr. An illustrated description of apparatus and working of the various systems. 5400 w. Engr, U S A—Jan. 15, 1902. No. 45598.

Fault Finding.

Fault Finding on Long Series Arc Circuits. F. B. O'Hanlon. The article applies more particularly to underground circuits and discusses methods of testing. 1000 w. Am Elect'n—Jan., 1901. No. 45333.

Lightning Arrester.

Horn-Shaped Lightning Arresters with Iron Armature (Hörnerblitzableiter mit Eisenarmirung). Eugen Klein. An illustrated description of a modification of the Elihu Thomson lightning arrester, in which iron plates are placed on the horns in order to drive the arc toward the far ends and extinguish it. 800 w. Elektrotech Zeitschr—Dec. 19, 1901. No. 45618 B.

Polyphase Circuits.

Elastic Polyphase Circuits (Elastische Drehstromleitungen). Prof. J. Teichmüller. A mathematical investigation of the behavior of polyphase circuits when the different phases are variously loaded, with diagrams. Serial. 2 parts. 6000 w. Elektrotech Zeitschr—Jan. 2, 9, 1902. No. 45626 each B.

Regulations.

Regulations for the Installation of Electric Conductors (Instruction Technique pour l'Etablissement des Conducteurs d'Energie Electrique). The proposed French official regulations for all kinds of aerial and underground electric wires. 2000 w. Revue Technique—Dec. 25, 1901. No. 45674 D.

Three-Phase.

Three-Phase Distribution for Power and Lighting. Sydney Woodfield. Presents the advantages of this system, and discusses other systems. Also briefly describes potential regulators. 2000 w. Elec Rev, Lond—Jan. 3, 1902. No. 45421 A.

ELECTRO-CHEMISTRY.

Cells.

The Dry Cell. C. F. Burgess. Gives a summary of tests made at the University of Wisconsin, by A. A. Radtke. 1300 w. Elec Wld & Engr—Jan. 25, 1902. No. 45721.

Chlorates.

The Corbin Process and Cell for the Electrolvtic Production of Chlorates. John B. C. Kershaw. Illustrated description of the process as operated at Chedde, in Savoy. 1000 w. Elec Rev, Lond—Jan. 17, 1902. No. 45764 A.

Electrolysis.

The Electrolysis of Fused Salts. Richard Lorenz. Discusses questions raised in an article by C. C. Gerrard, reviewing work of Mr. Lorenz. 1800 w. Elec Chem & Met—Dec., 1901. No. 45527 A.

Review of 1901.

The Electro-Chemical and Electro-Metallurgical Industries in 1901. John B. C. Kershaw. The present article reviews the condition of alkalies and bleach, aluminum, calcium carbide, and the chlorate industry. 4000 w. Elect'n, Lond—Jan. 3, 1902. Serial. 1st part. No. 45419 A.

Waste Tin.

The Recovery of Pure Tin from Waste Tin Cutttings by Electricity. F. Gelstharp. Describes a new process for the economical recovery by electricity. Ill. 2000 w. Elec Chem & Met—Dec., 1901. No. 45528 A.

ELECTRO-PHYSICS.

Diagrams.

Geometrical Loci in Alternating-Current Diagrams (Geometrische Oerter in Wechselstromdiagrammen). M. Schenkel. A mathematical article showing the advantages of determining loci of quantities found by vector analysis. Diagrams. 1200 w. Elecktrotech Zeitschr—Dec. 19, 1901. No. 45617 B.

Electrostatic Field.

A Novel Reaction between Electrostatic Tubes of Force and Insulators (Sur une Nouvelle Réaction entre les Tubes Electrostatiques et les Isolateurs). W. de Nicolaiève. A record of experiments with insulating bodies in an electrolyte conveying a current. 600 w. Comptes Rendus—Dec. 30, 1901. No. 45844 D.

Geissler Tubes.

Contribution to the Study of Geissler Tubes in a Magnetic Field (Contribution à l'Etude des Tubes de Geissler dans un Champ Magnetique). H. Pellat. An experimental study of electric discharges in vacuum tubes. 800 w. Comptes Rendus—Dec. 23, 1901. No. 45841 D.

Induction.

Laws of Electric Energy (Lois de l' Energie Electrique). E. Carvallo. A note criticising Maxwell's laws of electromagnetic induction and offering substitutes, with short account of experiments. 700 w. Comptes Rendus—Dec. 23, 1901. No. 45840 D.

Kirchhoff's Laws.

Extension of Kirchhoff's Two Laws (Extension des Deux Lois de Kirchhoff). E. Carvallo. Extension of Kirchhoff's laws of currents in a network to conductors in three dimensions, to variable currents and to dielectrics. 800 w. Comptes Rendus—Dec. 30, 1901. No. 45843 D.

Magnetic Fields.

Alternating and Rotating Magnetic Fields. Harold B. Smith. An outline of the methods and laws by which magnetic fields are developed under the application of alternating electromotive forces and resulting currents. 2200 w. Jour Worcester Poly Inst—Jan., 1902. No. 45746 C.

Magnetization.

The Determination of the Magnetization Constants (Die Bestimmung der Konstanten in der Magnetisirungsfunction). E. Müllendorff. A mathematical discussion of formulæ expressing the relation between the magnetizing force H and the magnetic induction B, and their agreement with Kapp's experimental curves. Tables. 2400 w. Elektrotech Zeitschr—Jan. 9, 1902. No. 45631 B.

Oscillators.

An Experimental Investigation into the "Skin"-effect in Electrical Oscillators. C. A. Chant. An account of investigations made in the Jefferson Physical Laboratory, Harvard University. Ill. 5300 w. Am Jour of Sci—Jan., 1902. No. 45304 D.

Physiological Effect.

The Action of High Frequency Currents upon Animals (Action des Courants de Hautes Fréquence (Application Directe) sur les Animaux). H. Bordier et Lecompte, with remarks by M. d'Arsonval. A description of experiments proving that these currents penetrate into the bodies of animals, when electrodes are directly applied. 1200 w. Comptes Rendus—Dec. 30, 1901. No. 45845 D.

Radiography.

On the Existence of Rays which Undergo Reflection in the Radiation Emitted by a Mixture of Chlorides of Radium and of Barium (Sur l'Existence de Rayons qui Subissent la Réflexion dans le Rayonnement Emis par un Mélange de Chlorures de Radium et de Baryum). Th. Tommasina. A record of experiments proving the existence of such rays. 500 w. Comptes Rendus—Dec. 30, 1901. No. 45846 D.

Stereoscopic Röntgen Ray Pictures. Frank C. Perkins. Reviews some of the stereoscopic methods of locating foreign substances buried in the tissues of the body. Ill. 1400 w. Elec Wld & Engr—Jan. 18. 1902. No. 45710.

GENERATING STATIONS.

Capacity Limits.

Capacity Limits of Direct Current Dynamos and Motors. Alton D. Adams. States the limits that fix the safe capacity, discovering the distinctive features in their application. 2500 w. Engr, U S A—Jan. 1, 1902. Special no. No. 45577 C.

Dynamo Design.

The Calculation of the Fall of Potential in Alternating Current Generators (Berechnung des Spannungsabfalles von Wechselstromgeneratoren). J. Fischer-Hinnen. A discussion of the mathematical design of alternators and polyphase generators, particularly Prof. Potier's method, with tables and diagrams. 3000 w. Elektrotech Zeitschr—Dec. 26, 1901. No. 45622 B.

Edison Station.

The New Power Station of the New York Edison Company. Gives a brief description of the plants now in use and an illustrated description of the Waterside station, situated on the East River, between 38th and 39th sts. 5400 w. Eng Rec—Jan. 4, 1902. No. 45341.

The New Water Side Station of the New York Edison Co. Illustrated description of this station which furnishes current for lighting and power purposes. 6600 w. Power—Jan., 1902. No. 45472.

The Waterside Station of the New York Edison Company. The first of a series of fully-illustrated articles describing this large station, its equipment and operation. 4500 w. Elec Wld & Engr—Jan. 4, 1902. Serial. 1st part. No. 45396.

Electric Supply.

The Stretford Regulations as to the Supply of Electrical Energy. A copy of the regulations drafted by C. H. Wordingham. 3500 w. Elec Engr, Lond—Jan. 17, 1902. No. 45758 A.

Gas Driving.

A Gas Engine Driven Electric Power Plant at Saltley, England. Illustrated description of an electric power installation being placed in works for the manufacture of railway carriages and wagons of all types, street cars and all kinds of vehicles for heavy and light railways. 2000 w. Engr, U S A—Jan. 15, 1902. No. 45596.

Glasgow.

The Pinkston Power Station of the

Glasgow Corporation Electric Tramways. Arthur H. Allen. Illustrated description of what is undoubtedly the finest station yet built in the United Kingdom. 9000 w. Engr, U S A—Jan. 1, 1902. Special number. No. 45572 C.

High Potential.

The Control of High Potential Systems of Large Power. E. W. Rice, Jr. Briefly outlines the principles which the writer believes should govern in the layout of stations of normally large output, giving illustrated description of devices for controlling and switching used in the Metropolitan and Manhattan stations of New York city. 3900 w. Trans Am Inst of Elec Engrs—Dec., 1901. No. 45489 D.

Hydro-Electric Plant.

Shawenegan Falls Power Plant. Illustrates and describes features of an important installation in Canada. 1500 w. Sci Am—Jan. 18, 1902. No. 45518.

The Red Bridge Power Station of the Ludlow Manufacturing Company. Illustrated detailed description of recently built works at Ludlow, Mass., for developing about 5000 horse-power. 2700 w. Eng Rec—Dec. 28, 1901. No. 45225.

Isolated Plants.

An Interesting Residence Plant. Illustrates and describes the principal features of the equipment recently installed in a house at Newport, R. I. 500 w. Am Elect'n—Jan., 1902. No. 45330.

Dividing the Power in Isolated Plants. H. F. Schmidt. Describes a method by which a heavy and light load can be taken care of at the smallest first cost, and yet be operated at very good efficiency. Ill. 500 w. Am Elect'n—Jan., 1902. No. 45331.

Electrical Equipment of a Southern Newspaper Plant. Louis Elliott. Illustrates and describes the isolated plant of the "Dallas-Galveston News." 1700 w. Am Elect'n—Jan., 1902. No. 45328.

Electric Light and Power Installation at the Lancashire County Asylum, Rainhill. Particulars and illustrations of an interesting and carefully designed installation. 1400 w. Elec Engr, Lond—Jan. 17, 1902. No. 45756 A.

The Application of the Storage Battery to Isolated Plants. S. E. Rucker. Discusses systems carrying loads in club houses and buildings of a like nature, also those plants which operate during the day and have need of only a small portion of the capacity after 7 p. m., and methods of computing battery equipments. Ill. 4000 w. Am Elect'n—Jan., 1902. No. 45327.

The Economy of Isolated Electric Plants. Isaac D. Parsons. Mr. Parsons' second paper reviews, in a very accurate manner, the usually inaccessible field of power plants installed in residential buildings, with valuable results. 4500 w. Engineering Magazine—Feb., 1902. No 45825 B.

The Electric Equipment of a Large Hospital. Charles E. Knox. Illustrated detailed description of the lighting and power plant of the Lying-in Hospital, New York. 3500 w. Am Elect'n—Jan., 1902. No. 45326.

Lighting Station.

Central-Station Lighting. J. A. Seager. Thinks the stations should not only be well lighted, but should display the newest and most effective arrangements as an object lesson. Also discusses the proper source and distribution of station lighting, and other related matters. 2000 w. Elec Engr, Lond—Jan. 17, 1902. No. 45757 A.

Maidstone Electricity Works. Illustrated description of recently opened electric-lighting works. 2000 w. Elec Engr, Lond—Jan. 3, 1902. No. 45420 A.

Load Factors.

Electricity Works Load Factors. J. Gray Scott. Read before the Glasgow Technical College Scientific Society. Explains the peculiar conditions which control the generation and distribution of electricity for the purposes to which it is applied, the effect on the cost, and the means whereby the conditions may probably be made more favorable. 5400 w. Elec Engr, Lond—Dec. 20, 1901. No. 45258 A.

Load Factors and Circuit Breakers. Arguments showing the close connection between the load factor and circuit breaker and the need of judgment in estimating the limit of economy. 1800 w. Elec Rev, Lond—Dec. 27, 1901. No. 45267 A.

Manhattan Elevated.

Opening the Power Station of the Manhattan Elevated Railway. Illustrated description of the powerful stationary engines for driving the alternators for the New York Elevated railways. The total horse-power of the station will be 100,000. Also editorial. 2200 w. Sci Am—Jan. 11, 1902. No. 45380.

See also Railways and Tramways, Motive Power and Equipment.

Power Development.

Quebec Railway, Light and Power Co., Montmorency Falls. An illustrated description of this installation, it being one of the first developments under a high head in America. 2100 w. Can Engr—Jan., 1902. No. 45453.

Reconstruction.

Reconstructing or Modernizing Central Stations. O. M. Rau. Presents a plan for reconstructing many small stations which are operating with old inefficient apparatus. The installing of alternating current machinery. 1800 w. Elec Rev, N. Y—Jan. 25, 1902. No. 45724.

Rheydt-Gladbach.

The Rheydt-Gladbach Electric Installation (Das Electricitätswerk Rheydt-Gladbach). H. Leisse. An illustrated description of the electric station at Rheydt and the electric railway between that town and Gladbach, in Rhenish-Prussia. 2000 w. Elektrotech Zeitschr—Jan. 2, 1901. No. 45627 B.

San Francisco.

Plant of the Independent Electric Light and Power Company, San Francisco. Illustrated detailed description of a recently built plant. 1600 w. Elec Wld & Engr—Jan. 4, 1902. No. 45397.

The Independent Electric Light and Power Company. Illustrated description of a San Francisco plant representative of the latest and best American ideas of modern steam station practice. 6000 w. Jour of Elec—Dec., 1901. No. 45499.

Sparking.

Sparking Produced by Defective Commutators, and the Remedy. William Baxter, Jr. Discusses the requirements in order that commutator brushes may run without sparking and gives suggestions for correcting defects. Ill. 2000 w. Marine Engng—Jan., 1902. No. 45254 C.

Sparkless Commutation with Fixed Brushes. Claude W. Hill. Reviews the method of calculation which gave satisfactory results with the older forms of machine having copper brushes, and indicates the modification necessary to obtain satisfactory working with fixed carbon brushes and minimum gap excitation, by which means a minimum weight of machine may be obtained. 2500 w. Elec Rev, Lond—Jan. 10, 1902. No. 45543 A.

Supply Works.

The Crystal Palace District Electricity Supply Works. A detailed description of the station as it is since the recent alterations. Ill. 1700 w. Elect'n, Lond—Jan. 10, 1902. No. 45541 A.

Syracuse, N. Y.

The Central Station of the Syracuse Lighting Company. An illustrated description of an interesting well constructed station of medium size. 1200 w. Elec Rev. N. Y—Jan. 25, 1902. No. 45723.

Transformers.

Paralleling of Alternate-Current Transformers. Arnold G. Hansard. The object of the paper is to explain the principles in a simple way for those who do not care to study the subject mathematically. 1300 w. Elec Times—Jan. 16, 1902. No. 45755 A.

Winding.

Winding Field Coils from Flat Copper Strips. Illustrates and describes a machine which winds copper ribbons edgewise into coils for the fields of electrical machines. 3000 w. Ir Age—Jan. 2, 1902. No. 45242.

LIGHTING.

Chicago.

The Lighting System of the Chicago Edison Company. An illustrated study of the plant and methods of one of the largest electric lighting supply companies in the world. 4400 w. Elec Rev, N. Y—Jan. 11, 1902. No. 45456.

Incandescent Lamps.

A Study of the Variations in Luminous Intensity of Alternating-Current Incandescent Lamps during One Complete Alternation (Etude des Variations d'Intensité Lumineuse dans une Période, des Lampes à Incandescence Alimentées par Courants Alternatifs). C. Leonard and P. Janet. A description of experiments and results, with tables and curves. 4000 w. Bull Soc Internationale de Electriciens—Dec., 1901. No. 45835 E.

The Danger of Fire in the Use of Incandescent Lamps for Decoration (Feuersgefahr bei Verwendung von Glühlampen zur Dekoration). C. Ankersen. An account of experiments with incandescent lamps covered with wadding, which charred or burned and caused the lamps to break. 600 w. Elektrotech Zeitschr—Jan. 9, 1902. No. 45634 B.

The Incandescent Lamp of To-day. John W. Howell. A few facts relating to these lamps and the features that have made them popular. 700 w. Trans Am Inst of Elec Engrs—Dec., 1901. No. 45491 D.

Lighting Stations.

See Generating Stations.

Nautical Spectacles.

Method of Lighting the Great Water Tank at the Nouveau Cirque, Paris. Illustrated description. 1000 w. Sci Am —Dec. 28, 1901. No. 45223.

Nernst Lamp.

The Nernst Lamp. Illustrates and describes this lamp as commercially developed. 1100 w. Sci Am—Jan. 11, 1902. No. 45382.

Photometry.

The Present Status of the Question of a Standard of Light. Clayton H. Sharp. Discusses progress toward a satisfactory standard. At present photometrists are limited to a choice of either a pentane standard or the Hefner lamp as primary standards. 1000 w. Trans Am Inst of Elec Engrs—Dec., 1901. No. 45493 D.

Street Illumination.

Street Illumination and Units of Light. W. D'A. Ryan. An account of photometric comparisons made of open and enclosed arcs, giving curves. 2000 w. Trans Am Inst of Elec Engrs—Dec., 1901. No. 45490 D.

Vapor Lamps.

Electric Gas Lamps and Gas Electrical Resistance Phenomena. Peter Cooper Hewitt. Describes some of the phenomena exhibited by mercury gas lamps and some of the difficulties encountered in determining the relative values of the resistances therein. 2500 w. Trans Am Inst of Elec Engrs—Dec., 1901. No. 45494 D.

MEASUREMENT.

Armature Resistance.

Measurement of the Armature Resistance of Continuous Current Machines (Messung des Ankerwiderstandes von Gleichstrommaschinen). A. Wettler. A description, with diagrams and formulæ, of a method of measuring the resistance of various forms of armature windings. 800 w. Elektrotech Zeitschr—Jan. 2, 1902. No. 45628 B.

Cable Testing.

Methods of Eliminating Corrections for the Leads, etc., in Cable Testing. H. Savage. Begins an explanation of methods. Ill. 1200 w. Elec Rev, Lond—Jan. 17, 1902. Serial. 1st part. No. 45765 A.

Dynamometer.

The Electromagnetic Absorption Dynamometer. C. Arthur Conant and Clifton R. Hayes. Describes this novel piece of apparatus showing its good qualities and its faults. Ill. 3000 w. Jour Worcester Poly Inst—Jan., 1902. No. 45747 C.

Fault Localization.

The Localization of Faults in Submarine Cables (Eingrenzung von Fehlern in Seekabeln). A description of methods, with diagrams. 2400 w. Elektrotech Zeitschr—Jan. 2, 1902. No. 45629 B.

Induction Motors.

Complete Commercial Test of Polyphase Induction Motors Using One Wattmeter and One Voltmeter. A. S. McAllister. An interesting article offering suggestions tending toward the elimination of all unnecessary apparatus. Shows what may be computed from the use of a single wattmeter in connection with a polyphase induction motor, supplied from constant potential mains. 1800 w. Elec Wld & Engr—Jan. 11, 1902. No. 45468.

Meters.

Discussion at Buffalo, August 21st, of Papers by Lincoln, Haskins, Davis and Browne. Discussion of papers on meters and metering of electrical energy. 12400 w. Trans Am Inst of Elec Engrs—Dec., 1901. No. 45487 D.

The Influence of Terrestrial Magnetism on Instruments of Precision (Ueber den Einfluss des Erdmagnetischen Feldes auf Präcisionsinstrumente). Konrad Windmüller. An illustrated account of experiments which show the influence of the earth's magnetic field upon the readings of Weston voltmeters. 400 w. Elektrotech Zeitschr—Dec. 26, 1901. No. 45625 B.

Motor Testing.

The Testing and Management of Electric Motors. P. T. White. A discussion of methods of testing is commenced in the present article. 1400 w. Elec Rev, Lond—Dec. 27, 1901. Serial. 1st part. No. 45266 A.

Stray Currents.

Measurements of Stray Currents in Gas and Water Pipes (Messungen von Vagabundirenden Strömen in Gas und Wasserrohren). Absalon Larsen and S. A. Faber. An account of systematic investigations conducted in Copenhagen, with description of methods and maps, diagrams and tables. 3500 w. Elektrotech Zeitschr—Dec. 19, 1901. No. 45616 B.

Stress.

Thermo-Electric Measurement of Stress. C. A. P. Turner. A description of methods used, giving results obtained under somewhat unfavorable circumstances, with remarks regarding the errors, and the data that might be obtained by further investigations. 11300 w. Pro Am Soc of Civ Engrs—Jan., 1902. No. 45749 E.

Telephone Cable.

See Electrical Engineering, Communication.

POWER APPLICATIONS.

Asynchronous Motors.

Tests of a Compensated Asynchronous Motor (Die Ersten Versuchsresultate am Kompensirten Asynchronmotor). Alexander Heyland. An illustrated description of tests of an asynchronous alternating current motor, with compensation windings. 1500 w. Elektrotech Zeitschr—Jan. 9, 1902. No. 45632 B.

The Asynchronous Motor Run as a Synchronous One (Der Asynchronmotor als Synchronmotor). Ernst Danielson. An illustrated description of a method for running a non-synchronous motor synchronously by sending continuous current through the secondary winding. 700 w. Elektrotech Zeitschr—Dec. 26, 1901. No. 45623 B.

Cotton Mills.

Electricity in Southern Cotton Mills. George E. Walsh. Concerning the application of electricity as a source of power. 2000 w. Elec Rev, N. Y.—Jan. 4, 1902. No. 45402.

Furnace Power.

The Dynamo as an Adjunct to the Blast Furnace. Horace Allen. Describes applications of the electric current that may be made with advantage. 1000 w. Elec Rev, Lond—Jan. 3, 1902. No. 45424 A.

Haulage.

Electric Mine Haulage. W. B. Clarke. Explains the influence of grades, curves, track construction, etc., upon the capacity of locomotive required for a given work. 2700 w. Mines & Min—Jan., 1902. No. 45386 C.

Induction Motors.

Some Pointers on Induction Motors. Dr. Louis Bell. Discusses the objections often raised, and the wrong ideas prevalent, and gives information concerning their usefulness. 1500 w. Elec Wld & Engr—Jan. 18, 1902. No. 45709.

Machine Driving.

Electrically Driven Machine Tools. A. L. De Leeuw. Discussion of general principles, with illustrations showing application of motors. 4800 w. Mach, N. Y.—Jan., 1902. No. 45405.

Pumping.

A Mine-Pumping Plant with Electrically-Driven Centrifugal Pumps. Illustrated description of the plant installed in the silver mine of Horcajo, in Spain, stating the conditions to be met. 2000 w. Eng News—Jan. 23, 1902. No. 45730.

Electrically Driven Pumping Machinery (Elektrisch Betriebene Wasserhaltungen). Hr. Hansen. A paper giving an account of various electric pumping plants for mine drainage and particularly of the Riedler express pump, with discussion. 1500 w. Zeitschr d Ver Deutschr Ing—Jan. 4, 1902. No. 45610 D.

Electric Feed Pumps. A. Johnston. Discusses methods of regulating the amount of water. 1500 w. Elec Rev, Lond—Jan. 10, 1902. No. 45542 A.

Reversing Switch.

Automatic Protective Device for Reversing Switches with Continuous Current Motors (Selbstschutzvorrichtungen für Gleichstrommotoren an Wendeanlassern). Rudolph Krause. An illustrated description of starting and reversing apparatus by which sparking and excessive currents are prevented. 600 w. Elektrotech Zeitschr—Dec. 26, 1901. No. 45624 B.

Shipbuilding.

Electric Appliances in Shipbuilding Yards. Sydney F. Walker. A fully illustrated paper showing the advantages of electric power in shipyards for power distribution and for the operation of heavy tools. 3000 w. Engineering Magazine—Feb., 1902. No. 45822 B.

TRANSMISSION.

New Zealand.

An Electric Power Transmission Plant in New England. Oswald Haes. Abstract of a paper read before the Elec Assn of N. S. W. Description of the system and plant. 2500 w. Elect'n, Lond—Dec. 27, 1901. No. 45284 A.

Supply.

The Supply of Electrical Power Over Large Areas. F. J. Warden Stevens. Considers the question from a point of view of the public, the local authorities and the companies. 2000 w. Archt, Lond—Jan. 3, 1901. No. 45413 A.

MISCELLANY.

Carbon.

The Manufacture of Carbon for Electrical Purposes (Note sur la Fabrication des Charbons Agglomérés pour l'Electricité). J. Worms. A review of the manufacture of compressed carbons for arc lamps, batteries, microphones and other electrical purposes. 1400 w. Electricien—Dec. 14, 1901. No. 45854 B.

Electrical Progress.

Electrical Progress and Legislation: The Need of Revision. R. Percy Sellon. An address before the London Chamber of Commerce. Sketches the condition of the electrical industries in England and the causes that have placed the country in serious arrear of the position she should have attained. 3200 w. Elec Rev, Lond—Dec. 27, 1901. Serial. 1st part. No. 45268 A.

Electricity Tariffs.

Some Principles Underlying the Profitable Sale of Electricity. Arthur Wright. A defence of the maximum demand system, with suggestions for its modification. 4800 w. Elect'n, Lond—Dec. 20, 1901. Serial. 1st part. No. 45256 A.

Electric Supply.

Principles and Profits in Electrical Supply. W. B. Esson. A discussion of electricity tariffs, called out by paper of Mr. Arthur Wright. Considers the maximum demand system erroneous and sketches a proposed method of charging. 3300 w. Elec'n, Lond—Jan. 3, 1902. No. 45418 A.

Pan-American.

Electricity at the Pan-American Exposition (L'Electricité à l'Exposition de Buffalo). Georges Dary. A general review. 2800 w. Electricien—Nov. 9, 1901. No. 45849 B.

Review.

Electrical Progress in 1901. A review of the advances made during the year showing that it was a year of unusual progress. 2500 w. Elec Rev, N. Y.—Jan. 11, 1901. No. 45455.

Safety Rules.

Report on the New Safety Regulations of the Verband Deutscher Elektrotechniker (Bericht über die Neuen Sicherheitsvorschriften des Verbandes Deutscher Elektrotechniker). Dr. C. L. Weber. A review and discussion, at a meeting of the Elektrotechnische Verein, of the German electrical safety regulations. 2000 w. Elektrotech Zeitschr—Dec. 19, 1901. No. 45621 B.

GAS WORKS ENGINEERING

Acetylene.

Acetylene Lighting in Mines (Ueber Versuche mit Acetylen-Beleuchtung in Bergwerken). Abstracted from the *Zeitschrift für das Berg Hütten und Salinenwesen.* An account of trials of acetylene safety lamps and other lamps in German mines. 3000 w. Glückauf—Jan. 4, 1902. No. 45650 B.

A Note on an Acetylene-in-Oxygen Flame. Clayton H. Sharp. Brief account of experimental investigations on a flame produced by the combustion of a mixture of equal parts of acetylene and hydrogen in an atmosphere of oxygen. 800 w. Trans Am Inst of Elec Engrs—Dec., 1901. No. 45492 D.

The Third International Acetylene Congress at Paris in 1900 (Der III. Internationale Acetylen Congress in Paris 1900). Heinrich Koechlin. A general account of the organization of the congress and abstract of the proceedings. 3500 w. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 21, 1901. No. 45694 B.

Burner.

The Welsbach Gasoline Burner. Illustrated description of a lamp of high efficiency. 600 w. Sci Am—Jan. 25, 1902. No. 45702.

Coke-Oven Gas.

Coke Oven Gas for Lighting, Heating and Power (Ueber die Verwendung von Koksofengas zu Leucht Wärme und Kraftzwecken und die Verbesserung desselben durck Benzolcarburation). Hugo Kutscher. An account of the manufacture and use of coke oven gas and its enrichment by benzol, with a description of the plant at Everett, Mass. 3000 w. Glückauf—Dec. 28, 1901. No. 45647 B.

Combustion.

Combustion in Gas Producers and Benches. Robert W. Prosser. Facts on the working of gas producers showing the effects of various methods and the advantages and disadvantages of each. 3600 w. Am Gas Lgt Jour—Jan. 20, 1902. Serial. 1st part. No. 45581.

Distribution.

Gas Distribution at Leeds. Illustrated description of a system of extension and enlargement of mains. 1700 w. Gas Wld—Jan. 18, 1902. No. 45761 A.

Exhibition.

Gas at the Crystal Palace. An account of the exhibits shown at the International Gas Exhibition. Considers it a meagre representation of the industry and not fitly named. Ill. 5500 w. Gas Wld—Dec. 21, 1901. No. 45261 A.

High Pressure.

Thermal Emissivity in High-Pressure Gases. Discusses researches of Mr. J. E. Petavel which are of high interest to the engineer. An important contribution to thermo-dynamics. 3800 w. Engng—Jan. 3, 1902. No. 45427 A.

Incandescent Lighting.

Intensive Incandescent Lighting. M. Greyson de Schodt. Summary of a lecture to the Dutch Gas Assn. Explains the theory of incandescent lighting and gives an illustrated description of recent improvements made by the writer. 1500 w. Gas Wld—Dec. 21, 1901. No. 45262 A.

Liquor Distillation.

The Use of Lime in Liquor Distillation. E. Blum. The substance of a paper read before the Mid-Rhenish Assn of Gas & Water Engrs. Illustrates and describes the method and apparatus for preparing concentrated ammoniacal liquor. 1700 w. Jour of Gas Lgt—Jan. 7, 1902. No. 45524 A.

Mixtures.

Explosive Gas Mixtures. Dr. H. Bunte. Abstract translation of a paper read before the German Assn of Gas & Water Engrs. Gives tabulated results of explosion investigations and explains the behavior of gases under various conditions. 2800 w. Jour Gas Lgt—Dec. 24, 1901. Serial, 1st part. No. 45263 A.

Modern Practice.

Modern Practice in the Manufacture and Distribution of Gas. Harry Edward Jones. Extracts from a paper read before the Inst. of Civ. Engrs. of London, Eng. Considers the influence of Welsbach light, the coin meter, and sliding scale legislation, labor-saving machines, residuals, etc. 5000 w. Pro Age—Jan 15, 1902. Serial. 1st part. No. 45504.

Natural Gas.

Natural Gas in 1900. F. H. Oliphant. Information from the Mineral Resources of the United States for 1900. 2500 w. Pro Age—Jan 15, 1902. No. 45505.

Oil Gas.

Gas from Oil. Process as conducted on the Pacific coast. Facts relative to the producing gas oils in the state of California, an' the methods of using them. Ill. 1500 w. Am Gas Lgt Jour—Jan. 13, 1902. No. 45466.

Paris.

The Gas Question in Paris (Le Nouveau Régime du Gaz à Paris). A review of the report of M. Lauriol, chief engineer for lighting in Paris, on plans for the improvement and increase of the gas supply, by private companies or the city itself. 2800 w. Génie Civil—Dec. 21, 1901. No. 45659 D.

The Gas Question in Paris. Particulars from a report by M. Lauriol, studying a scheme for new works and discussing the cost of manufacture, and other matters of interest. 2500 w. Jour Gas Lgt—Jan. 7, 1902. No. 45523 A.

Water Gas.

Carburetted Water Gas in Europe. J. T. Westcott. An account of the development. 1600 w. Am Gas Lgt Jour—Jan. 27, 1902. No. 45725.

INDUSTRIAL ECONOMICS

INDUSTRIAL ECONOMICS.

Consolidation.

Consolidated Labor. Carroll D. Wright. An analysis of the attitude of the public and of law toward labor unions, and the attitude of labor unions toward industrial society. 6400 w. N Am Rev—Jan., 1902. No. 45302 D.

Corporate Developments.

Mr. James J. Hill on Consolidations, Competition and Rates. Address on the relations of railways to the public interests, delivered at Fargo, N. D., before the Grain and Stock Growers' Convention. 2800 w. Ry Age—Jan 17, 1902. No. 45558.

Education.

American Educational Wisdom. Stuart Uttley. A comparison of the general attitude of the people in England and America toward technical education. 3500 w. Ir Age—Jan. 30, 1892. No. 45786.

The Education of Mechanical Engineers and Chemists in the Higher Mechanical Schools of Russia. M. Sserebroffsky and G. von Doepp. An account of the schools at present devoted to this work, their regulations, courses of study, etc. 3000 w. Sib Jour of Engng—Jan., 1902. No. 45751 C.

Employes.

Pension and Insurance System Adopted in Providence. Describes a scheme for providing employes with pensions, sick benefits, and insurance. 1500 w. St Ry Rev—Jan 15, 1902. No. 45566 C.

Factory Act.

The Factory Act, 1901. Discusses the new matter in the act that came into force on Jan. 1, 1902, in Great Britain. 2200 w. Engr, Lond—Dec. 27, 1901. No. 45289 A.

Foreign Commerce.

A Neglected Factor in Our Commercial Expansion. Albert Halstead. On the value of American consular service and the reports published. 3300 w. N Am Rev—Jan., 1902. No. 45301 D.

Health.

The Hygiene of Workers in Mines. Dr. E. W. King. Discusses some of the causes that tend to impair the health and shorten the lives of those employed in this vocation. 5000 w. W Min Wld—Jan. 11, 1902. No. 45502.

Inventory.

See Mechanical Engineering Machine Works and Foundries.

Iron Trade.

The Chicago Iron Trade in 1901. George W. Cope. A review of the year which is reported as more active than any previous year. Discusses the conditions, the strike, consolidations, trade, prices. etc. 4800 w. Ir Age—Jan. 2, 1902. No. 45243.

The Eastern Iron Markets. Thomas Hobson. A review of the year, considering pig iron, billets, exports, finished material, old material, etc. 3300 w. Ir Age—Jan. 2, 1902. No. 45246.

The Pittsburg Iron Trade in 1901. Robert A. Walker. A review discussing the general features, consolidations, foreign trade, new construction, labor troubles, prices, the outlook, etc. 1200 w. Ir Age—Jan. 2, 1902. No. 45245.

Labor.

Australian Labor Laws and Their Bearing on Trade Unionism. Stafford Ransome. Discusses the new law in Australia and its effect, but does not assume that even if it works well there, it would apply to Great Britain or other countries. 2000 w. Engr, Lond—Jan. 3, 1902. No. 45441 A.

Labor Unions and Labor Contracts. D. L. Cease. Discusses the benefits expected from the labor contracts, and the improved attitude of workmen. 1700 w. Gunton's Mag—Jan., 1902. No. 45359 C.

Patent Office.

The Patent-Office Library. Illustrates the new patent-office, Southampton Buildings, describing the new library recently opened. 1500 w. Engr, Lond—Jan. 10, 1901. No. 45554 A.

Premium System.

Premium Plan of Rewarding Labor. H. M. Norris. Stenographer's report of paper read before the Engine Builders' Assn. An explanation of the system as introduced at the works of The Bickford Drill & Tool Co., Cincinnati, Ohio. 4800 w. Engr, U S A—Jan. 1, 1902. Special number. No. 45578 C.

The Premium Plan at the Works of David Rowan and Company, Glasgow, Scotland. James Rowan. Also "The

Origin of the Premium Plan." A Personal Statement by F. A. Halsey. Descriptive article. 3700 w. Am Mach—Jan. 9, 1902. No. 45454.

Prizes.

Prizes Awarded by the French Academy for 1901 (Prix Décernés Année 1901). A list of prizes and sketches of the recipients. Also prizes offered for 1902, 1903, 1904, 1905 and 1906. 20000 w. Comptes Rendus—Dec. 16, 1901. No. 45839 D.

Review.

1901. A review of the year's history in Great Britain in mechanical and electrical engineering, gas supply, war material and chemistry. 20500 w. Engr, Lond—Jan. 3, 1902. No. 45438 A.

Sanitary Engineering and Water Supply in 1901. Reviews the results of the year in sewage disposal, water supply, and related matters. 4000 w. Engr, Lond—Jan. 3, 1902. No. 45436 A.

Sault Ste. Marie.

Engineering and Industrial Enterprises at Sault Ste. Marie. An illustrated general description of the various industrial enterprises centered here. 8000 w. Eng News—Jan 9, 1902. No. 45365.

Subsidy.

Ship Subsidy Bill. A copy of the bill introduced in the U. S. Senate by Mr. Frye. 2200 w. Marine Engng—Jan., 1902. No. 45253 C.

Workmen's Dwellings.

Austro-Hungarian Legislation for Encouraging the Erection of Sanitary and Cheap Workmen's Dwellings (Regierungsvorlage betreffend Begünstigungen für Gebäude mit Gesunden und Billigen Arbeiterwohnungen). A review of proposed legislation giving privileges to buildings of the class named, relieving them from taxes, etc. 3000 w. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 7, 1901. No. 45684 B.

Works Management.

Money-Making Management for Workshop and Factory. C. U. Carpenter. The first of an important series of papers. This instalment deals with the executive, working and recording departments. 4000 w. Engineering Magazine—Feb., 1902. No. 45823 B.

Problems in the Management of a Railway Shop. R. T. Shea. Gives illustrations of chances for saving in some of the larger shops. 1300 w. Loc Engng—Jan., 1902. No. 45316 C.

Shop Administration. W. W. McLaren. Stenographer's report of paper read before Engine Builders' Assn. States the conditions and discusses questions bearing upon development and operation. 2700 w. Engr, U S A—Jan. 1, 1902. Special number. No. 45574 C.

The Commercial Management of Engineering Works. G. Siebert. Discussing the relation of mercantile and engineering talent, and showing how the combination of both is essential to attain commercial success. 2500 w. Engineering Magazine—Feb., 1902. No. 45820 B.

MARINE AND NAVAL ENGINEERING

Battleship.

The Japanese Battleship Mikasa. Illustration, with plan and section, and full description of what is said to be "the finest battleship in the world." 2200 w. Engr, Lond—Jan. 10, 1902. No. 45551 A.

The Launch of the Battleship "Missouri." Illustrated description of this vessel, the last of the three of the "Maine" class, launched Dec. 28, 1901. 1200 w. Sci Am—Jan. 11, 1902. No. 45379.

Car Ferries.

Car Ferry (Les Car-Ferries). An account of ice-breaking ferryboats on the American Great Lakes. 1200 w. Revue Technique—Dec. 25, 1901. No. 45672 D.

Cargo Boats.

Developments in Cargo-Boat Machinery. Benjamin Taylor. Traces developments of the marine engine during the last quarter of the last century. 3800 w. Marine Rev—Dec. 26, 1901. No. 45212.

Coal-Carrying.

Ocean Transportation for Coal. Information concerning the transportation of coal from Great Britain and America to France. 1600 w. U S Cons Repts, No. 1234—Jan. 9, 1902. No. 45297 D.

Cobra Disaster.

The Loss of the British Torpedo Boat Destroyer "Cobra" (La Perte du Contre-Torpilleur Anglais "Cobra"). S. Gradier. A description of this steam-turbine vessel and her loss with a review of the court of inquiry proceedings. 2000 w. Génie Civil—Dec. 28, 1901. No. 45661 D.

Cruiser.

German Cruiser König Wilhelm Ersatz. Illustrated description of interesting changes which place this vessel in advance of the Prinz Heinrich. Tabulated data of recent cruiser designs are given. 1500 w. Engr, Lond—Dec. 27, 1901. No. 45292 A.

Fire Boats.

New and Powerful Steel Fire Boat. Illustrates and describes a new boat to be built for the city of Milwaukee. 2200 w. Marine Rev—Jan. 16, 1902. No. 45582.

Twin-Screw Fire Float for Durban Harbor. Illustrations, with brief description, of a boat recently built for the Natal Government. 400 w. Engng—Jan. 10, 1902. No. 45547 A.

Harbor Boats.

Harbor Lighterage and Transportation. H. L. Joyce. A study of the system in New York Harbor, its growth, difference in style of craft from time to time, and the many changes in methods and in class of traffic. Also discussion. 10500 w. N Y R R Club—Dec. 19, 1901. No. 45449.

Hydrography.

See Civil Engineering, Measurement.

Icebreakers.

Ice Breaking in Germany (Eisbrechwesen in Deutschland). Hr. Boost. A historical sketch of methods of breaking up ice in rivers with explosives, and a review of modern ice-breaking boats for rivers and harbors. 700 w. Zeitschr d Ver Deutscher Ing—Dec. 21, 1901. No. 45601 D.

"Kronprinz Wilhelm."

The New German Liner "Kronprinz Wilhelm" (Der Neue Deutsche Schnelldampfer "Kronprinz Wilhelm"). An illustrated general account of this great North German Lloyd Steamship. 1000 w. Glasers Ann—Jan. 1, 1902. No. 45614 D.

Merchant Marine.

The Transformation of the Merchant Marine (Transformation du Materiél de la Marine Marchande). Mr. Vetillart. Report presented to the VIII International Congress of Navigation. An important paper. 15000 w. Ann des Ponts et Chaussées—2 Trimestre, 1901. No. 45810 E+F.

"Neckar."

The Imperial-Mail Steamship "Neckar" (Der Reichspostdampfer "Neckar"). A fully illustrated description of this North German Lloyd 18,700 ton steamship, and of its boilers, engines and fittings. 2 plates. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 4, 1902. No. 45605 D.

Non-Sinkable.

The Non-Sinkability of Large Steel Ships (L'Insubmersibilité des Grands Navires d'Acier). M. E. Duchesne. Advocating the use of double hulls, as well as water-tight bulkheads for the prevention of disasters at sea. 3500 w. Mem Soc Ing Civ de France—Nov., 1901. No. 45819 G.

Resistance.

The Hydraulics of the Resistance of Ships. Edgar C. Thrupp. Read before the Glasgow Congress. An investigation of the discovery that there is an enormous divergence from the laws of stream line motion when the dimensions of the channels or pipes are such as to have hydraulic radii exceeding 1 in. or 2 ins. 3300 w. Engng—Dec. 20, 1901. No. 45275 A.

Shipbuilding.

Present Tendencies of Lake Ship Building. Waldon Fawcett. Comments on the return to normal size, instead of building the large vessels introduced at the close of the last century. Also notes other tendencies in the most recent vessels. Ill. 1700 w. Am Mfr—Jan. 23, 1902. No. 45586.

Shipbuilding and Marine Engineering in 1901. A review of the ship tonnage constructed in the works of the United Kingdom. 3700 w. Engng—Jan. 3, 1902. Serial. 1st part. No. 45432 A.

Shipbuilding and Marine Engineering During 1901. A review of the year; the present article dealing with the volume of work and its broad general features, as well as with the measure of activity in the several districts of the United Kingdom. 3500 w. Engr, Lond—Jan. 10, 1902. Serial. 1st part. No. 45550 A.

The Development of American Shipbuilding in the Last Decade (Die Entwickelung des Amerikanischen Schiffbaues im Letzten Jahrzehnt). Prof. Oswald Flamm. Abstract of a paper by Tjard Schwarz before the "Schiffbautechnische Gesellschaft" on shipbuilding, and cranes and other shipyard appliances in the United States. Ill. 1200 w. Stahl u Eisen—Jan. 1, 1902. No. 45640 D.

See also Electrical Engineering, Power Applications.

Ship Railway.

See Civil Engineering—Canals, Rivers and Harbors.

Shipyards.

Japanese Shipyards. Editorial on the progress Japan is making towards the supply of her own fleet. 2500 w. Engng—Jan. 3. 1902. No. 45431 A.

Notes on the Equipment of Foreign Shipyards. C. C. Thomas. Describes the appliances used in British shipyards, comparing them with the American yards. 3000 w. Marine Engng—Jan., 1902. No 45248 C.

Stability.

A Stability Diagram. George Crouse Cook. A practical method of calculating and plotting a series of curves of the centers of buoyancy, from which the curve of statical stability may be deduced for any variations in displacement or loading. 1200 w. Naut Gaz—Jan. 2, 1902. No. 45404.

Steamship Design.

Design of Ocean Steamers. Theodore Lucas. Discussion of the designing of ships for particular uses, giving diagrams. 2000 w. Naut Gaz—Jan. 2, 1902. No. 45403.

Steamships.

New Ships of the Boston Steamship Company. Illustrates and describes two 11,000 ton freight steamships now under construction. 1100 w. Marine Engng—Jan., 1902. No. 45247 C.

Subsidy.

See Industrial Economics.

Tank Experiments.

Experiments upon the Propulsion of Models of Ships (Esperienze di Propulsione con Modelli di Navi). Nino Pecoraro. A discussion of experiments in the testing tank at the Arsenal at Spezia, with especial reference to the use of electrically operated propellers on the models. 6000 w. 2 plates. Rivista Marittima—Dec., 1901. No. 45800 E+F.

Testing Tank.

The Equipment of the Canal of the Hydraulic Laboratory of Cornell University for Experimental Work on the Resistance and Propulsion of Ships. Dr. William F. Durand. Describes this canal and the equipment thus far installed. Ill. 2000 w. Sib Jour of Engng—Jan., 1902. No. 45752 C.

Turbine Steamer.

Turbine Steamer **King Edward. W.** Cartile Wallace. An illustrated article giving information concerning this boat and the general impression her arrangements made on the writer. 3000 w. Marine Engng—Jan., 1902. No. 45249 C.

Warships.

Progress of Warships and Machinery Building in England. A résumé of the progress made in naval construction during the last six months. 1700 w. Engr, Lond—Dec. 27, 1901. No. 45290 A.

Warship building in 1901. A review of the additions during the year to the British Navy. 2500 w. Engng—Dec. 20, 1901. Serial. 1st part. No. 45276 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol Fuel.

Alcohol and Automobiles. From *The Motor World.* Discusses the recent tests of this fluid in the neighborhood of Paris. 1400 w. Sci Am Sup—Jan. 25, 1902. No. 45708.

Alcohol Automobiles at the Paris Alcohol Exhibition. The present article gives an illustrated description of the Gobron-Brillié system. 800 w. Sci Am—Dec. 28, 1901. Serial. 1st part. No. 45222.

Alcohol Motors.

See Mechanical Engineering, Special Motors.

Automobile Show.

Résumé of the New York Automobile Show. Alex. Schwalbach. An illustrated article pointing out the most striking characteristics. 4000 w. Auto Mag—Jan., 1902. No. 45210 C.

Classification.

The Rational Classification of Motor Vehicles. Albert L. Clough. Considers the only logical method of classification to be on the basis of the ratio of the actual maximum horse power capable of being continuously delivered by the motor to the total weight carried. 1200 w. Horseless Age—Jan. 1, 1902. No. 45338.

Comparison.

The Vehicles of To-day and Yesterday. C. C. Bramwell. A comparison of the vehicles which took part in the first automobile run from New York, with those which participated in the Endurance Run. 1200 w. Horseless Age—Dec. 25, 1901. No. 45235.

France.

The Automobile in France To-day. Hart O. Berg. Abstract of a lecture, delivered at the Automobile Club of America. 4300 w. Auto Mag—Jan., 1902. No. 45211 C.

Ignition.

Ignition. Ernest J. Hutton. Extracts from a paper that is to form a part of a book on motor driving, soon to be issued. 4500 w. Autocar—Jan. 11, 1902. No. 45509 A.

Internal Combustion.

Generation and Distribution of Hot Gases in Internal Combustion Engines. Charles E. Lucke. Discusses points in hot gas generation and some of the principles to be considered in designing these engines. 2500 w. Horseless Age—Jan. 15, 1902. Serial. 1st part. No. 45521.

Lubrication.

Positive and Cleanly Lubrication. Albert L. Clough. Explains forced feed lubrication and its advantages. 900 w. Horseless Age—Jan 8, 1902. No. 45373.

Motor Car.

An Interesting Car Built by an Amateur. An account of the experiences of C. H. Johnson, of Leeds, Eng., in amateur motor car construction. Ill. 1700 w. Autocar—Jan. 18, 1902. Serial. 1st part. No. 45760 A.

Motor Vehicles.

The Business Vehicle Problem. Robert G. Pilkington. Discusses the general form of delivery wagons, and the applications. 2000 w. Horseless Age—Jan. 1, 1902. No. 45337.

Paris Exhibition.

The Paris Automobile Exhibition. Illustrates and describes some of the more important exhibits at what proved to be a most successful exhibition, the profits reaching about $20,000. 5500 w. Auto Jour—Jan., 1902. No. 45769 A.

The Paris Autocar Show. An illustrated description of some of the leading novelties exhibited. 13600 w. Autocar—Dec. 21, 1901. No. 45260 A.

The Paris Motor Car Show. An account of this annual exhibition of motor vehicles, the exhibits, and the changes noted. Ill. 2500 w. Engr, Lond—Jan. 3, 1902. Serial. 1st part. No. 45435 A.

Road Lessons.

The Troubles and Pleasures of an Inexperienced Beginner With a Gasoline Automobile. Harry B. Haines. A report of experiences while learning to manage the machine. 2800 w. Horseless Age—Jan. 22, 1902. No. 45589.

Single Cylinder.

The Packard Single Cylinder Motor Wagon. Hugh Dolnar. A full illustrated description of the mechanical details of this new vehicle. 4300 w. Autocar—Dec. 28, 1901. No. 45285 A.

Sparking.

Spark Control. Albert L. Clough. A discussion of spark regulation on automobile engines. 1000 w. Horseless Age—Jan. 22, 1902. No. 45587.

Speed Gear.

The Howard Speed Change Gear. Illustrated description of a new speed gear of the planetary type. 1100 w. Horseless Age—Jan. 15, 1902. No. 45522.

Standardization.

The Standardization of Controlling Mechanisms. Albert L. Clough. Urges the general adoption of that method which offers the most advantages. 1200 w. Horseless Age—Jan. 8, 1902. No. 45374.

Steam Engines.

Patterns and Core Boxes for the Hyler White Steam Engine. W. O. Anthony. Illustrates and describes the construction. 4000 w. Horseless Age—Jan. 22, 1902. No. 45588.

The Superheated Steam Engine. Henri G. Chatain. Describes these engines and discusses their advantages for road locomotion. 1700 w. Horseless Age—Jan. 15, 1902. No. 45520.

Steam Vehicles.

The "Locomobile" Steam Carriage. Illustrated detailed description. 2000 w. Sci Am Sup—Jan. 25, 1902. No. 45707.

The Steam Motor Car. An illustrated article explaining the mechanism of one of the latest cars. 2500 w. Engr, Lond—Dec. 20, 1901. No. 45280 A.

Trucks.

Merchandise Transport by Automobile Trucks (Transport par Cannons Automobiles). M. Bret. An examination of the various types of motor trucks with regard to their availability for service in the streets of Paris. 10000 w. Ann des Ponts et Chaussées—2 Trimestre, 1901. No. 45811 E + F.

Tyres.

Hints on the Use and Care of Tyres. H. Wilton Bartlett. Discusses tyre diameters, wheel sizes, oil, nipping patches, etc. 2500 w. Autocar—Jan. 18, 1902. No. 45759 A.

War Office Trials.

The War Office Heavy Motor Vehicle Trials. Full illustrated description of the mechanical features of the lurries, with observations on their performance. 7000 w. Auto Jour—Jan., 1902. No. 45768 A.

HYDRAULICS.

Canal Power.

How Chicago Will Harness the Drainage Canal. Edward P. Ellicott. Explains how the construction of this canal has created an opportunity for developing a great water power, discussing the advantages to be derived. 1500 w. Mod Mach—Jan., 1902. No. 45445.

Flow.

A Proposed Solution of Some Hydraulic Problems. Discussion of the paper by Charles H. Tutton. 2500 w. Pro Am Soc of Civ Engrs—Dec., 1901. No. 45220 E.

A Proposed Solution of Some Hydraulic Problems. Continued discussion of a paper by Charles H. Tutton. 1700 w. Pro Am Soc Civ Engrs—Jan., 1902. No. 45750 E.

Current Meter and Weir Discharge Comparisons. Continued discussion of paper by Edward C. Murphy. 600 w. Pro Am Soc of Civ Engrs—Dec., 1901. No. 45218 E.

Experiments at Detroit, Mich., on the Effect of Curvature Upon the Flow of Water in Pipes. Continued discussion of paper by Gardner S. Williams, Clarence W. Hubbell and George H. Fenkell, Jr. 5000 w. Pro Am Soc of Civ Engrs—Dec., 1901. No. 45216 E.

Ice Troubles.

Freeing the Niagara Canal Races from

Ice. Arthur B. Weeks. Illustrates and describes the methods and appliances used. 450 w. Am Elect'n—Jan., 1902. No. 45334.

Plumbing.

Plumbing in the Tombs Prison, New York. Illustrates and describes the hot and cold water supply and drainage system of the new part of the Tombs prison. 2200 w. Eng Rec—Jan. 4, 1902. No. 45344.

Pumping Plant.

Centrifugal Pumping Plant for Wallasey Dock. Illustrated description of one of the largest plants of its kind erected and working in Great Britain. 800 w. Engr, Lond—Jan. 10, 1902. No. 45553 A.

Pumps.

Ventilators and Centrifugal Pumps for High Pressures Driven by Steam Turbines or Electric Motors (Ventilateurs et Pompes Centrifuges pour Hautes Pressions, Mus pas Turbines â Vapeur ou par Moteurs Electriques). M. Rateau. An elaborate and well illustrated record of investigations showing the superiority of the steam turbine for driving high pressure ventilating fans and centrifugal pumps. 11000 w. Bull Soc d'Encour—Dec., 1901. No. 45677 G.

Pumping Machinery.

See also Electrical Engineering, Power Applications.

Turbines.

On a Leaf Arrester for the Water Supply of a Turbine. Earl of Rosse. Illustrates and describes an apparatus that has worked successfully in directing the leaves to a side channel and into the tail-race. 700 w. Engng—Jan. 10, 1902. No. 45548 A.

The Development of the Turbine (Die Entwickelung der Turbine). Prof. R. Escher. A historical sketch of turbines and their regulating apparatus. 2 parts. 6000 w. Schweiz Bauzeitung—Dec. 21, 28, 1901. No. 45837 each B.

MACHINE WORKS AND FOUNDRIES.

Boiler Plates.

Table for Finding the Thickness of Boiler Plates. George F. Summers. Table with brief explanation of its use. 400 w. Am Mach—Jan. 16, 1902. No. 45533.

Case Hardening.

Case Hardening for Fine Grain. E. R. Markham. Explains how machine steel may be hardened so as to produce a fine grain. 1500 w. Am Mach—Jan. 2, 1902. No. 45394.

Case Hardening Wrought Iron and Machine Steel. E. R. Markham. Gives directions for the work. 2000 w. Am Mach—Jan. 23, 1902. No. 45594.

Points to be Observed in Case Hardening. E. R. Markham. Discusses some points concerning the composition and peculiarities of the stock and materials used. 800 w. Am Mach—Jan. 16, 1902. No. 45531.

Castings.

Casting Bases for Upright Boilers. R. H. Palmer. Illustrated description. 500 w. Am Mach—Jan. 2, 1902. No. 45392.

Molding a Sawmill Bed. R. H. Palmer. Illustrated description. 1000 w. Am Mach—Jan. 16, 1902. No. 45534.

Cast-Iron Pipes.

English and French Practice in the Manufacture of Cast-Iron Pipes. I. English Practice. Stephen H. Terry. II. French Practice. A. G. Cloake. Two papers read before the British Assn. of Water-Works Engrs. 3700 w. Ir & Coal Trds Rev—Dec. 20, 1901. No. 45271 A.

Drawing Room.

Drawing Room; Chief Engineer's Office; Pittsburg & Lake Erie R. R., Pittsburg, Pa. R. P. Forsberg. Illustrated description of the room, tables, card index system, drawings, filing cases, blue print room, etc. 3200 w. Eng News—Jan. 2, 1902. No. 45345.

Engine Building.

Modern Engine Building. Notes taken at the shops of the Westinghouse Machine Company. Ill. 3000 w. Mach, N. Y.—Jan., 1902. No. 45406.

Fly-Wheels.

Building a Fly Wheel. An illustrated description of methods employed. 1800 w. Power—Jan., 1902. No. 45473.

The Design and Construction of Fly Wheels for Slow Speed Engines for Electrical Lighting and Traction Purposes. A. Marshal Downie. Read before the Inst. of Engrs. & Shipbuilders in Scotland. Discusses the design and application of fly-wheels to large slow speed engines. Ill. 2000 w. Engrs' Gaz—Jan., 1902. Serial. 1st part. No. 45414 A.

Foundry.

A Steel Frame Foundry Building. Illustrated description of a fire-proof structure at Harrison, N. J. 1800 w. Eng Rec—Jan. 4, 1902. No. 45342.

New Steel Foundry of the Pennsylvania Steel Company. An illustrated description of a recently completed foundry at Steelton, Penn. It is operated by electricity and all details are strictly up-to-date. 1500 w. Ir Age—Jan. 30, 1902. No. 45783.

Gear Cutting.

The Bilgram Automatic Bevel Gear Generating Machine. Illustrated description of the machine and its operation.

1400 w. Am Mach—Jan. 23, 1902. No. 45593.

Gear Teeth.

Wear of Gear Teeth. Robert A. Bruce. Compares the relative wear of different portions of the profile and the relative amounts of wear which may be expected under assumed conditions to take place in teeth with each of the standard profiles. Ill. 2200 w. Prac Engr—Jan. 3, 1902. No. 45416 A.

Grinding.

Safety Appliances for Grinding Machines (Protection des Meules Artificielles). Henry Mamy. A well illustrated account of various ventilating and other safety appliances for the protection of persons running grinding machines. 1 plate. 4000 w. Génie Civil—Dec. 21, 1901. No. 45658 D.

Guns.

Repairing Worn-Out Guns on Service. R. Bannatine-Allason. Short illustrated description of a somewhat novel operation of re-lining a damaged 12-pounder 6 cwt. gun. 1000 w. Engr, Lond—Jan. 10, 1902. No. 45556 A.

Inventory.

Aids in Taking the Machine-Shop Inventory. Hugo Diemer. Discussing a simple method of employing the card index and showing its advantages for inventory purposes. 2500 w. Engineering Magazine—Feb., 1902. No. 45827 B.

Leakages.

Some Leakages in Factory Practice. Walter J. May. Calls attention to points that have been noticed by the writer. 2700 w. Prac Engr—Dec. 27, 1901. No. 45287 A.

Light Shapes.

Modern Plants for the Manufacture of Hoops and Merchant Bars. Theodore J. Vollkommer. Illustrates and describes plants where automatic machinery has been introduced, and improved methods. 5300 w. Ir Age—Jan. 16, 1902. No. 45460.

Lubricating Oils.

Friction of Lubricating Oils. R. H. Thurston. Discusses some of the results obtained, and the deductions drawn. 1200 w. Am Mach—Jan. 23, 1902. No. 45592.

Machine Driving.

See Electrical Engineering. Power Applications.

Machine Methods.

Modern Machine Methods. H. F. L. Orcutt. Deals with machine operations, where accuracy and cheapness is secured, as contrasted with laborious and expensive hand work or machines without modern improvements. A suggestive paper to those considering economical methods of manufacture. Ill. 10300 w. Inst of Mech Engrs—Jan., 1902. No. 45754 D.

Machine Tools.

A Universal Portable Machine Tool. Illustrated descriptions of devices for drilling, boring and mining, and of the methods of using them. 900 w. Engng—Jan. 17, 1902. No. 45774 A.

Recent Machine Tools (Neuere Werkzeugmaschinen). Prof. F. Bock. A well illustrated description of machine tools manufactured by Sattler, Berner & Co., of Nuremberg, Germany. Serial. Part I. 800 w. Zeitschr d Ver Deutscher Ing—Jan. 4, 1902. No. 45608 D.

New Works.

Stanley Works, Newark-on-Trent. Illustrated detailed description. 4500 w. Engr, Lond—Dec. 20, 1901. No. 45282 A.

Piecework.

Piecework: Its Evils and Remedies. Gilbert Fox. Discusses this system and its working. 2200 w. Prac Engr—Jan. 10, 1902. No. 45510 A.

Planers.

Some Early Planer Inventions. H. O. Coombs. Illustrates and describes interesting machines of machine tool designs in England. 700 w. Am Mach—Jan. 2, 1902. No. 45395.

Shop Methods.

Some Jobbing Shop Methods. Joseph V. Woodworth. Illustrates and describes cutting a coarse pitch screw, making thin threaded brass rings, a stepping jig for drilling small holes, etc. 3500 w. Am Mach—Jan. 2, 1902. No. 45393.

Shop Work.

The Limit Gauge System of Shop Work. W. H. Booth. Read before the Glasgow Scientific Society. An illustrated article explaining the system and its application. 2500 w. Prac Engr—Dec. 27, 1901. Serial. 1st part. No. 45286 A.

Taper Tubes.

Fixture for Forming Taper Tubes with Feed Motion for the Blanks. Moses G. Wilder. Illustrated description of a fixture where the blanks are fed across the front of the press from left to right, and capable of forming 100 to 150 tubes per minute. 1100 w. Am Mach—Jan. 16, 1902. No. 45532.

Tools.

Fixtures and Tools for Making Speed Indicators. Joseph Vincent Woodworth. Illustrated description. 800 w. Mach, N. Y.—Jan., 1902. No. 45408.

Machine Shop Tools for Engine Builders. George T. Reiss. Presented at meeting of Engine Builders' Assn. An illustrated description of appliances of special character that are useful for special purposes. 3500 w. Engr, U S A—Jan. 15, 1902. No. 45599.

The Tool Chest. A series of descriptive articles presenting the most approved modern hand tools and devices used by mechanics for purposes of drawing, measurement, adjustment, and getting accurate work. Ill. 900 w. Mod Mach—Jan., 1902. No. 45448.

Turret Tools. Illustrated description of tools used for machinery gear blanks in the turret lathe. 1100 w. Mach, N Y—Jan., 1902. No. 45407.

Turning Machine.

A New Crank Pin Turning Machine. Illustrated description of a machine where the work remains stationary and the tool travels around it. 1000 w. Ir Age—Jan. 16, 1902. No. 45459.

Works Management.

See Industrial Economics.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys of Copper and Tin. William Campbell. Read before the Inst. of Mech. Engrs. An appendix to the reports of the Alloys Research Committee. Research made to explain the complete freezing point curve of the copper-tin alloys, and to note the change of structure due to casting. Ill. 4700 w. Engng—Jan. 3, 1902. Serial. 1st part. No. 45433 A.

Notes on Alloys of Copper and Iron. J. E. Stead. Read before the Glasgow Congress. A report of research prosecuted during the last year, describing methods and giving results; also showing the influence of carbon in these alloys. Ill. 6000 w. Engng—Dec. 20, 1901. 45277 A.

Upon the Constitution of Binary Alloys. John Alexander Mathews. Gives a résumé of the knowledge gained by the researches of metallurgists, and outlines the present knowledge concerning the nature and constitution of binary alloys. Ill. 5300 w. Jour Fr Inst—Jan., 1902. Serial. 1st part. No. 45372 D.

Budapest Congress.

The Budapest Meeting of the International Association for the Testing of Materials (Vom Internationalen Materialprüfungs Congress in Budapest). Prof. H. Wedding. A paper, with discussion, before the "Eisenhütte Oberschlesien," giving an account of the Budapest Congress, the proposed international laboratory at Zürich, etc. 2800 w. Stahl u Eisen—Jan. 1, 1902. No. 45637 D.

The Third Congress of the International Association for the Testing of Materials (Der III. Congress des Internationalen Verbandes für die Materialprüfungen der Technik). K. Haberkalt and A. Stradal. A report of the meeting at Budapest and abstract of the proceedings. 9000 w. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 21, 1901. No. 45692 B.

Gun Tests.

The Gathmann Gun Tests. Grahame H. Powell. Some explanatory notes concerning the recent test at Sandy Hook, showing the effect of outside explosion. Ill. 1300 w. Am Mach—Jan. 16, 1902. No. 45530.

Leather.

A Chemical Study of Leather (Etude Chimique du Cuir). Ed Nihoul. An exhaustive study of the operations of tanning leather, with especial reference to its uses in the mechanic arts. Serial. Part I. 7500 w. Rev Univ des Mines—Dec., 1901. No. 45802 H.

Magnalium.

Alloys of Aluminum and Magnesium (Les Alliages d'Aluminium et de Magnesium). O. Boudouard. A well illustrated account of investigation of these alloys with various proportions of the metals, giving melting points, microscopic examination, etc. 2000 w. Bull Soc d' Encour—Dec., 1901. No. 45678 G.

Steel.

How Should Steel for Girders be Tested? Considers how the material should be tested to ascertain whether it is in accordance with the requirements of the specification. 2200 w. Engr, Lond—Jan. 10, 1902. No. 45552 A.

POWER AND TRANSMISSION.

Compressed Air.

Central Compressed Aid Power Plants. From *Granite*. Reviews briefly the conditions that have made these plants necessary, describing a typical installation. 2800 w. Compressed Air—Jan., 1902. No. 45501.

Compressed Air Haulage Plants. Richard Hirsch. An illustrated general description of a plant and its operation, with discussion. 6800 w. Pro Engrs Soc of W Penn—Dec., 1901. No. 45298 D.

SPECIAL MOTORS.

Acetylene Motors.

Acetylene for Gas Engines. Reviews investigations made with this gas as a motive power, and also what has actually been done in everyday work. 3000 w. Engr, Lond—Jan. 17, 1902. No. 45777 A.

Alcohol Motors.

Alcohol in Industry (L'Alcool per le Industrie). The report of the commission of the Italian Government upon the proposed methods of using methylated and carburetted alcohol for heating and motive power. 2500 w. L'Industria—Jan. 5, 1902. No. 45806 D.

Alcohol Motors in Germany (Les Locomobiles à Alcool en Allemagne). Lucien Périssé. A review of an article in *Vie Scientifique,* giving an account of applications of alcohol motors in agricultural and other work. 800 w. Revue Technique—Dec. 10, 1901. No. 45669 D.

French Spirit Motors. An account of the steps being taken in France and Germany to use alcohol for driving motors, and for lighting and heating purposes. Discusses also the construction of spirit motors. 2500 w. Engng—Jan. 10, 1902. No. 45546 A.

Ether Motor.

An Ether-Vapor Generator. From *La Nature.* Gives an account of the early attempts to apply this liquid for the production of motive power and gives an illustrated description of the seeming solution in the invention of Desvignes de Malapert. 2000 w. Sci Am—Jan. 4, 1902. No. 45357.

The "Latent Heat" Fallacy. R. H. Thurston. Discusses the false ideas advanced in relation to the new ether vapor engines. 2000 w. Sci Am Sup—Jan. 25, 1902. No. 45705.

Gas Engines.

High Power Gas Engines: Conditions Necessary for Their Successful Working. A. Rollason. Read before the Glasgow and West of Scotland Technical College Scientific Society. Reports, in the present article, tests made of two types of engines to determine their respective capabilities, giving indicator cards. 1300 w. Prac Engr—Jan. 10, 1902. No. 45511 A.

The Gasoline Power Engine. E. W. Roberts. Gives a simple rule for calculating the power of gas engines. 800 w. Min & Sci Pr—Dec. 28, 1901. No. 45351.

What to Do When the Gas Engine Stops. Albert Stritmatter. Discusses the proper method to pursue to locate a trouble when the cause is unknown. 2000 w. Am Mfr—Jan. 9, 1902. No. 45444.

Ignition.

The Wydts Electro-Catalytic Sparking Plug. Illustrated description of a device for exploding the charges of gas in a gas or gasoline engine, without the use of electricity or heat; also editorial. 2500 w. Sci Am—Jan. 18, 1902. No. 45515.

Internal Combustion.

The Internal Combustion Engine. An illustrated elementary explanation of its working. 2500 w. Autocar—Dec. 21, 1901. No. 45259 A.

Wave Motor.

The Santa Cruz Wave Motor. H. W. H. Penniman. Brief description with illustration. 450 w. Sci Am—Jan. 4, 1902. No. 45356.

STEAM ENGINEERING.

Boilers.

Design, Construction and Operation of the Steam Boiler. W. H. Wakeman. Discusses problems concerning the theoretical and practical strength, durability, installation, care and operation of boilers now in actual service. 1700 w. Ill. Mod Mach—Jan., 1902. Serial. 1st part. No. 45447.

Troubles with Boilers. W. F. Durand. Considers some of the more frequent derangements and the measure available for their prevention or repair. 3400 w. Engr, U S A—Jan. 1, 1902. Special number. No. 45573 C.

Boiler Explosion.

Report on a Boiler Explosion (Bericht über eine Dampfkessel Explosion). An account of a boiler explosion at Essen, Germany, and the probable causes thereof. 1 plate. 900 w. Glückauf—Nov. 23, 1901. No. 45641 B.

Chimneys.

Chimneys. George A. Orrok. How to determine height and calculate draft; methods of construction are discussed. 2000 w. Power—Jan., 1902. No. 45474.

The Horse Power of a Chimney. W. H. Wakeman. Considers only natural draft, and explains how to calculate the horse power. 1500 w. Elec, N Y—Jan. 15, 1902. No. 45498.

Comparative Practice.

English, American, and Continental Steam Engineering. Philip Dawson. Mr. Dawson's concluding paper is devoted to American engines and traction power houses, with numerous illustrations. 4000 w. Engineering Magazine—Feb., 1902. No. 45824 B.

Cylinder Clearance.

Effect of Cylinder Clearance upon Steam Economy. Ira C. Hubbell. Illustrates graphically and demonstrates the important relation between cylinder clearance and steam consumption. 4300 w. St. Louis Ry Club—Dec. 31, 1901. No. 45299.

Feed Pump.

Boiler Feed Pump Operation in Isolated Plants. J. N. Cravath. A discussion of methods. 1000 w. Am Elect'n—Jan., 1902. No. 45336.

Feed Water.

Feed Water for Boilers. G. James Wells. Abstract of a paper read before the Manchester Soc. of the Inst. of Elec. Engrs. Discusses the difficulties that arise in working boilers, due to impure water, and discusses in detail the various objectionable qualities found in feed waters, and the remedies. 3000 w. Elect'n, Lond—Jan. 17, 1902. No. 45763 A.

Some Rudimentary Considerations Concerning the Treatment of Water for Locomotive Use. R. P. C. Sanderson. Some points on methods of water doctoring are discussed. 1500 w. Am Engr & R R Jour—Jan.. 1902. No. 45312 C.

Governors.

Investigations of Inertia Governors for Steam Engines (Untersuchung der Beharrungsregler an Dampımaschinen). C. Körner. A theoretical and mathematical study. with figures. 5000 w. Zeitschr d Ver Deutscher Ing—Dec. 28, 1901. No. 45603 D.

Shaft Governors—Some Troubles with Them. Hubert E. Collins. Gives experiences and points out, in a general way a few rules to be observed, and how to handle some of the makes in general use. 1400 w. Engr, U S A—Jan. 15, 1902. No. 45597.

High-Speed.

High-Speed Steam Engines. John Davidson. Read before the Liverpool Engng. Soc. Deals generally with engines of the quick-revolution type, setting forth their advantages over the slow revolution type. 1200 w. Engr, Lond—Jan. 3, 1902. Serial. 1st part. No. 45440 A.

Liquid Fuel.

Liquid Fuel for Steam Boilers, Forges, and Furnaces. W. H. Wakeman. Reviews the history of the use of crude oil, and describes the commonly used instruments for drilling oil wells, the process of distillation, oil burners, etc., giving cautions regarding safety in the use. Ill. 5800 w. Engr, U S A—Jan. 1, 1902. Special number. No. 45575 C.

Test of Texas Oil. An account of a comparative test with coal and oil, and the results. Ill. 2700 w. Ir Age—Jan. 30, 1902. No. 45784.

Rolling Mill Engine.

Triple Rolling Mill Engine. Gives drawings and comparison with the Neepsend rolling mill engine. 1200 w. Engr, Lond—Jan. 17, 1902. No. 45778 A.

Safety Valves.

The Size of Lever Safety Valves. R. A. Douglass. Discusses methods of determining the discharging capacity of safety valves. Ill. 3000 w. Am Elect'n—Jan., 1902. No. 45329.

Smoke Prevention.

The Schulz-Knaudt Smoke Prevention Apparatus (Rauchverhütungsvorrichtung der Firma Schulz-Knaudt in Essen). Trnovsky. A short, illustrated description abstracted from the *Zeitschrift des Baierischen Dampfkessel-Revisionsvereines.* There is a combustion chamber behind the grate, fed with air from above. Results of successful tests are given. 600 w. Oester Wochenschr f d Oeffent Baudienst—Dec. 14, 1901. No. 45690 B.

Speed Regulation.

The Experimental Determination of the Regulation of Steam Engine Speeds (Une Methode de Mesure Expérimentale de la Régularité des Machines à Vapeurs). M. L. E. F. David. The angular variations of a single revolution are measured by the vibrations of a tuning fork. 1200 w., 23 plates. Bull Soc Internationale Electriciens, and Atlas Nos 9 & 9 bis—Nov., 1901. No. 45801. Each E.

Steam Engines.

See Automobiles.

Steam Generation.

Some Notes on the Generation of Steam and Its Economical Application. H. A. Clark. Abstract of a paper presented to the Yorkshire College Engng Soc. 2100 w. Horseless Age—Jan. 8, 1902. No. 45375.

The Hoffman System of Steam Generation. Jos. W. Jones. An illustrated description of a system combining to a certain extent the good features of the gasoline and steam systems. Claims very high thermal efficiency and consequent fuel economy. 1000 w. Horseless Age—Dec. 25, 1901. No. 45236.

Steam Turbines.

Industrial Applications of Parson's Steam Turbines (Applications Industrielles des Turbines à Vapeur Parsons). M. Duchanoy. A well illustrated account of various applications of steam turbines to dynamo-driving and ship propulsion. 5000 w. Génie Civil—Dec. 21, 1901. No. 45-657 D.

Superheating.

Superheated Steam and the Schwoerer Superheater (La Vapeur Surchauffee et le Surchauffeur Schwoerer). Abstract of a paper by M. Nolet on superheated steam and the results obtained with the Schwoerer superheater. 3500 w. Revue Technique—Dec. 10, 1901. No. 45666 D.

Valve Gear.

The Corliss Valve Gear. J. Begtrup. Illustrated descriptions of the Corliss valves discussing their limitations, dimensions, etc. 3200 w. Am Mach—Jan. 23, 1902. No. 45595.

MISCELLANY.

Aeronautics.

Some Aeronautical Experiments. Wilbur Wright. An interesting illustrated address reviewing the difficulties met and the work of various aeronauts, and giving an account of the experiments made by the writer. 8800 w. Jour W Soc of Engrs—Dec. 1, 1901. No. 45305 D.

Travel in Air. I. Lancaster. An examination of the action of birds with a view of discovering how their flight is controlled. 4500 w. Engr, Lond—Dec. 20, 1901. No. 45281 A.

Cooling.

Cooling Power and Conductivity of Air (Pouvoir Refroidissant et Conductibilité de l'Air). P. Compan. Note of experiments on the cooling off of a copper ball in a glass globe filled with dry air. 500 w. Comptes Rendus—Dec. 23, 1901. No. 45842 D.

Grain Storage.

Grain Storage in Elevators on the Huart System (La Conservation des Grains dans les Greniers du Système Huart). G. Espitallier. Review of an article by M. Adrian in the *Revue du Service de l'Intendance,* giving an illustrated description of this system, in which the grain is stored in large metal bins and changed from one to another every week or two. 1400 w. Génie Civil—Jan. 4, 1902. No. 45663 D.

Heating.

Central Station Heating (Fernheizwerke). An account of a large steam plant for heating various public buildings in Dresden, Saxony. 1500 w. Zeitschr d Ver Deutscher Ing—Jan. 4, 1902. No. 45609 D.

Hot Water Indirect Heating in a Rochester School. Describes the interesting features of the installation. Ill. 2000 w. Eng Rec—Jan. 4, 1902. No. 45343.

Lighting, Heating and Ventilation in the Nassau County Court House, Mineola, N. Y. The heating is largely by means of direct-indirect radiation, and lighted by electricity. Illustrated description. 2200 w. Eng Rec—Jan. 18, 1902. No. 45720.

The Cooling-Off and Heating of Closed Spaces Ueber Abkühlung und Erwärmung geschlossener Räume). Dr. G. Recknagel. A theoretical, mathematical article. This part discusses the loss of heat from closed rooms, taking into account interior and external temperatures, fall of temperature in the walls, etc. 6000 w. Zeitschr d Ver Deutschr Ing—Dec. 21, 1901. No. 45600 D.

The Temporary Warming of the Large Hall of the Palace Library, Vienna, Austria. Prof. Edward Meter. Read before the Am. Soc. of Heat & Ven. Engrs. Describes an interesting piece of work to meet unusual conditions. 1100 w. Met Work—Jan. 25, 1902. No. 45700.

Hot Water.

Note on the Flow of Hot Water through and from Pipes (Note sur l'Ecoulement de l'Eau Chaude par les Tuyères). A. Rateau. An explanation, by means of the entropy diagram, of some hot-water and steam flow phenomena observed by M.M. Savage and Pulin in 1892. Diagrams. 2400 w. Revue de Mecanique—Dec. 31, 1901. No. 45675 E+F.

Mechanical Plant.

Mechanical Installation in the Modern Office Building. Continued discussion of paper by Charles G. Darrach. 6500 w. Pro Am Soc of Civ Engrs—Dec. 1901. No. 45219 E.

Nail Manufacture.

The Walloon Nail Industry (Die Nagelschmieden der Wallonen). C. Ritter von Schwarz. An illustrated account of primitive nail manufacturing carried on in some districts of Belgium. Serial. 2 parts. 7000 w. Stahl u Eisen—Jan. 1, 15, 1902. No. 45638 D.

Radiation.

Modern Radiation Investigations (Ergebnisse der Neueren Strahlungsmessungen). Dr. Clemens Schaefer. Modern theories of radiation, the relation between wave length and temperature of light and heat rays, etc., with figures and tables. 4500 w. Zeitschr d Ver Deutscher Ing—Jan. 4, 1902. No. 45607 D.

Refrigeration.

Cooling Plant in Butterine Factory. Illustrates and describes the refrigerating and power plant of the Capital City Dairy Co., Columbus, O. 2300 w. Ice & Refrig —Jan., 1902. No. 45364 C.

Sugar Machinery.

The Evaporation of Juice. A. E. Jordan. On the importance of adopting a more economical apparatus for the evaporation of the water contained in juice. Gives illustrations and descriptions of the most modern evaporators, the present article presenting the Yaryan, and the Lillie types. 3800 w. Engng—Jan. 3, 1902. Serial. 1st part. No. 45428 A.

Ventilating Fans.

See Mechanical Engineering, Hydraulics.

Ventilation.

Hospitals and Contagious Diseases and Their Ventilation. Thomas Barwick. Read before the Am. Soc. of Heat & Ven. Engrs. Describes the best design for such buildings and the details of a ventilating system. 1800 w. Met Work—Jan. 25, 1902. No. 45701.

The Proper Method of Heating and Ventilating Public Buildings. Gives the views of Prof. S. Homer Woodbridge of the Massachusetts Inst. of Technology, who has recently had charge of the ventilation of the Capitol at Washington. 1600 w. Dom Engng—Jan. 15, 1902. No. 45580 C.

Water Softening.

The Largest Water Softening Plant in the World. Illustrated account of the plant at Otterbourne, near Southampton, England, which treats over four million gallons a day. 3300 w. Ir & Coal Trds Rev—Jan. 17, 1902. No. 45,774.

MINING AND METALLURGY

COAL AND COKE.

Alabama.

Alabama Coal Mining. Neill Hutchings. Describes some general features of the developments in the Pratt Seam in the Birmingham District, Ala. 1800 w. Mines & Min—Jan., 1902. No. 45387 C.

British Columbia.

Coal Discoveries in British Columbia. An account of a recent trip into the center of the province, with particulars of the coal discoveries. 1800 w. Col Guard—Dec. 20, 1901. No. 45274 A.

Coal Cutting.

A German Report on Coal-Cutting Machinery in America. Excerpts from the report of Herr R. Mellin, which appeared in *Glückauf* of Dec. 7, 1901. Describes the conditions, methods of working, etc., and gives conclusions regarding the use of these machines in Germany. Comments also on various types. 3300 w. Col Guard—Jan. 17, 1902. No. 45772 A.

Coal-Fields.

The Coal Fields of Las Esperanzas, Coahuila, Mex. Edwin Ludlow. Describes the formation of this basin; the charact ristic feature is the 1,150 ft. of shale underlying the heavy sandstones. Also gives an illustrated description of the operations. 5000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 45787 D.

Coal Washing.

Washing of Bituminous Coals by the Luhrig Process. J. V. Schaefer. Briefly discusses coal-washing in general and the appliances used, and gives an illustrated detailed description of a Luhrig plant and its operation. Also discussion. 7500 w. Jour W Soc of Engrs—Dec. 1901. No. 45306 D.

Screen.

The New Seltner Coal Screen (Der Neue Sortirrost "Patent Seltner"). Erich Mladek. Illustrated description of a coal-separating screen in successful use in Austria. 1 plate. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 28, 1901. No. 45833 B.

Slate Pickers.

American Slate Pickers. Briefly describes some of the machines which have given good results. 1500 w. Col Guard—Jan. 17, 1902. No. 45773 A.

COPPER.

Butte, Montana.

The Gem-Jessie Copper and Silver Group at Butte. Map and information concerning a new group of copper mines which have become very interesting of late. The veins are true fissure veins; strong well-defined copper veins, carrying a higher percentage of silver than the more southern veins. 600 w. Eng & Min Jour—Jan. 18, 1902. No. 45564.

Japan.

Copper Mining in Japan. E. W. Nardin. Abstract of a paper read before the Royal Society of New South Wales. An account of the Ashio Mine, the largest producer of copper in the Empire, the manner of working, treatment of the ore, &c. 2600 w. Eng & Min Jour—Dec. 28, 1901. No. 45241.

1901.

Copper in 1901. Reports a moderate decrease for the first time for a number of years, discussing the production of various districts. Also reviews the market. 3500 w. Eng & Min Jour—Jan. 4, 1902. No. 45463.

Selector.

The David Selector and the Metallurgy of Copper. Illustrates and describes an invention that has brought success in the application of the Bessemer process to the metallurgy of copper. 700 w. Sci Am Sup—Jan. 25, 1902. No. 45706.

GOLD AND SILVER.

Assaying.

The Detection and Estimation of Small Quantities of Gold and Silver. Luther Wagoner. A detailed account of method employed in measuring approximately the amount of gold and silver contained in one cubic centimeter of sea-water, and some of the results obtained. 4000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 45789 D.

British Columbia.

A Review of Mining Operations in Boundary District, During 1901. E. Jacobs. Ill. 3700 w. B. C. Min Rec—Jan., 1902. No. 45451 C.

British Columbia—Vancouver Island Mines and Prospects. William M. Brewer. An account of a recent visit to the Mount Sicker and the Alberni Canal mining districts. Map. 4400 w. Eng & Min Jour—Dec. 28, 1901. No. 45240.

Notes to Accompany One Plan and Three Vertical Sections of the Athabasca Mine, on Toad Mountain, near Nelson, British Columbia. E. Nelson Fell. 1100

w. Can Min Rev—Dec. 31, 1901. No. 45354 B.

Notes on Recent Progress in the Lardeau District. J. McLellan. Briefly describes characteristics of this district which yields gold and silver ores and many minerals of value. Ill. 1700 w. B C Min Rec—Jan., 1902. No. 45452 C.

Cyanide Process.

A Method of Testing Cyanide Solutions Containing Zinc. Leonard M. Green. Read before the Inst. of Min. & Met., London. Proposes a method of analysis by which satisfactory technical results can be obtained with a fair degree of accuracy and in a reasonably short time. 1100 w. Min Rept—Dec., 1901. Serial. 1st part. No. 45529.

A Review of Progress in the Cyanide Process During the Year 1901. J. S. C. Wells. An account of the decided progress in the United States and Canada, reporting concerning the various localities. 7000 w. Eng & Min Jour—Jan. 4, 1902. No. 45462.

The Cyanide-Assay for Copper. Harry Huntington Miller. Describes a method used in employing the cyanide-assay to make a large number of determinations of very low-grade materials whose accuracy within one or two hundredths per cent. was necessary. 1800 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 45790 D.

The Cyanide Process. C. A. Mulholland. Extracts from a paper read before the Sydney Tech. Col. Min. & Met. Soc. Some theoretical considerations on the solution of gold in this process. 2400 w. Aust Min Stand—Nov. 28, 1901. No. 45526 B.

Egypt.

Gold Mining in Egypt. Charles J. Alford. Abstract of a paper read before the Inst. of Min. & Met. in London. From the report of an expedition sent out in the winter of 1899-1900, with description of subsequent explorations. Ill. 4700 w. Eng & Min Jour—Jan. 18, 1902. No. 45562.

Low Grade Silver.

Mills of the San Juan Region, Colorado. Frank Hartman. Illustrated description of the means by which the great low-grade silver deposits have been made profitable. 2300 w. Mines & Min—Jan., 1902. No. 45385 C.

Mexico.

The Mining District of Pachuca, Mexico. Ezequiel Ordonez. Gives a general description, the history, topography, geology, vein-phenomena, &c. Gold, silver, and other metals are found. 7000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 45797 D.

New South Wales.

The Kiandra (N. S. W.) Field. E. C. Andrews. Gives the history of this gold field, describing the formation in the present article. 3000 w. Aust Min Stand—Nov. 28, 1901. Serial. 1st part. No. 45525 B.

Ore Treatment.

Ore Treatment in Westralia. Donald Clark. An illustrated description of the filter press processes for gold slimes. 2700 w. Aust Min Stand—Dec. 5, 1901. No. 45415 B.

Placers.

The Breckenridge, Colorado, Placer Problem. Wade L. Crow. Abstracts from the Colorado School of Mines Bulletin No. 3. A description of the deposits of the low flats and bars, with a discussion of the different methods of exploitation attempted. Ill. 3000 w. Min Rept—Jan. 9, 1902. Special number. No. 45495 C.

Review.

Gold and Silver in 1901. A review of the production during the year, in the United States, and the other parts of the world. Also considers the commercial movement. 5200 w. Eng & Min Jour—Jan. 4, 1902. No. 45461.

Slimes.

The Treatment of Clay-Slimes by the Cyanide Process and Agitation. E. A. H. Tays and F. A. Schiertz. Describes the character of the slimes, and their successful treatment. The material was very unfavorable but held high gold values. Ill. 9500 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 45799 D.

Stamp-Batteries.

The Pachuca Stamp-Battery and Its Predecessors. M. P. Boss. An outline of the evolution of the stamp-battery. 1400 w. Trans Am Inst of Min Engrs—Nov. 1901. No. 45792 D.

Tailings.

The Treatment of Tailings by the Cyanide Process at the Athabasca Mine, near Nelson, British Columbia. E. Nelson Fell. Describes the principal features of this plant for treating gold ores, and the methods employed in its operation. Ill. 3900 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 45796 D.

IRON AND STEEL.

Analysis.

Variations of Carbon and Phosphorus in Steel (Schwankungen von Kohlenstoff und Phosphor im Flusseisen). Axel Wahlberg. Paper before the Iron and Steel Institute giving the results of careful analyses made by eminent chemists, showing the variations. Tables. 4500 w. Stahl u Eisen—Jan. 15, 1902. No. 45656 D.

Austria-Hungary.

The Production of Steel during the Nineteenth Century in Austria-Hungary (Die Erzeugung von Flusseisen und Stahl im XIX. Jahrhundert in Oesterreich-Ungarn). Franz Kupelwieser. Statistical tables, with discussion, showing the preponderance of basic open-hearth steel. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 14, 1901. No. 45828 B.

Blast Furnaces.

Operation of Blast Furnaces (Bedingungen eines Guten Hochofenganges). G. Teichgräber. Practical points on blast furnace working, advocating the periodic changing of the blast pressure. 800 w. Stahl u Eisen—Jan. 15, 1902. No. 45654 D.

The Blast-Furnace Plant at Porto Vecchio, Italy (Die Hochofenanlage von Portovecchio). George Martin. An illustrated description of a blast furnace and pipe casting works on the west coast of Italy, using ore from Elba. 1600 w. Stahl u Eisen—Jan. 15, 1902. No. 45652 D.

The Eliza Blast Furnaces (Die Eliza-Hochofenanlage). Fritz W. Lürmann. Review of an article in the *Iron Age*, giving an illustrated description of the Jones and Laughlin's blast furnaces near Pittsburg. 2200 w. Stahl u Eisen—Jan. 15, 1902. No. 45653 D.

Crucible Steel.

Crucible Steel. Its Manufacture and Treatment. David Flather. Abstract of a paper read before the South Staffordshire Iron & Steel Inst. Briefly considers the process of manufacture, its uses and treatment by the consumer. 7000 w. Ir & Coal Trds Rev—Dec. 20, 1901.. Serial. 1st part. No. 45272 A.

Foundry Iron.

The Manufacture of Foundry Pig Iron and Foundry Practice in General (Herstellung von Giessereiroheisen und der Giessereibetrieb im Allgemeinen). Hr. Grau. An historical review of blast furnace practice in Germany and an account of foundry practice. Paper before the "Eisenhütte Oberschlesien," with discussion and illustrations. 6000 w. Stahl u Eisen—Jan. 1, 1902. No. 45636 D.

Furnace Linings.

Refractory Materials. Percy Longmuir. A brief review of these materials and their general properties, showing the treatment needed to prepare them for industrial conditions. 2300 w. Ir Trd Rev—Jan. 23, 1902. No. 45585.

Germany.

Production of Iron and Steel in Germany and Luxemburg (Zehnjährige Uebersicht der Gesamtproduktion an Eisen im Deutschen Zollgebiet einschl. Luxemburg). Statistical tables for the years from 1890 to 1900, of the production of iron ore, iron and steel. 400 w. Glückauf—Nov. 23, 1901. No. 45644 B.

Iron Trade.

See Industrial Economics.

Ladle Crane.

Revolving Crane for Ladle (Giess-Rollkrahn). Ad. Schuchart, Sr. An illustrated description of a revolving crane carrying a pouring ladle serving two open-hearth furnaces at the Harkort works at Wetter-on-the-Ruhr, Germany. 1 plate. 500 w. Stahl u Eisen—Jan. 15, 1902. No. 45655 D.

Liquid Fuel.

Naphtha Fuel for Open-Hearth Furnaces (Naphthafeuerung für Martinöfen). Adrian Byström. From *Jernkontorets Annaler*. An illustrated description of methods of using oil fuel in metallurgical work in Russia. 1000 w. Glückauf—Nov. 23, 1901. No. 45643 B.

Old Rails.

The Re-Rolling of Old Rails (Das Neuwalzen infolge Langen Gebrauches Deformirter Eisenbahnschienen). Hr. Litschauer. From the *Bány. Koh. Lapok*. A note on the early re-rolling of worn rails at the Salgo-Tarjaner works in Hungary, with illustrations of rail sections. 300 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 21, 1901. No. 45832 B.

Pig Iron.

The Pig Irons of the Sieg District and their Utilization (Das Roheisen des Siegerlandes und seine Verarbeitung). Hr. Münker. An account of the different varieties of pig iron made in this Rhenish-Prussian district, and of their further use in the manufacture of iron and steel. 1400 w. Zeitschr d Ver Deutschr Ing—Dec. 28, 1901. No. 45604 D.

Rail Rolling.

Rolling Rails at Low Temperature. Editorial review of article by S. S. Martin, published in the Iron Age and the Railroad Gazette. 1800 w. R R Gaz—Jan. 24, 1902. No. 45737.

Standardization.

Standardization of Tests for Iron and Steel. W. H. Farnell. Read before the W. of Scotland Iron & Steel Inst. Discusses the present practice showing the necessity of standardization, and considering the requirements and test limits. 4500 w. Ir & Coal Trds Rev—Dec. 20, 1901. No. 45270 A.

Steel.

The Heat Treatment of Steel. M. E. Vanderheym. On the advantages of annealing and rapid cooling. 1800 w. Ir Age—Jan. 30, 1902. No. 45785.

Steel Manufacture.

The Talbot and the Combined Bessemer-Martin Process (Talbotverfaren und Combinirter Bessemer-Martin-Process). E. Holz. A paper before the "Eisenhütte Oberschlesien" on steel manufacture, particularly at Witkowitz, Austria, with discussion. 3500 w. Stahl u Eisen—Jan. 1, 1902. No. 45635 D.

Steel Works.

The Clarence Works of Bell Brothers, Limited. An illustrated historical sketch of these works and the successive steps by which this important business has been built. 3000 w. Ir & Coal Trds Rev—Jan. 10, 1902. No. 45544 A.

The Dominion Iron and Steel Company. An illustrated sketch of a great industrial enterprise at Sidney, Nova Scotia. 3400 w. Marine Rev—Jan. 2, 1902. No. 45339.

Tool Steel.

Alloyed Tool Steel. H. W. Rushmer. Read at meeting of the Railroad Master Blacksmiths' Assn. Discusses the properties of alloy tool steel, and the principles of working this material. 2300 w. Min Rept—Jan. 2, 1902. No. 45362.

MINING.

Accidents.

The Prussian Mine Accident Commission (Die Verhandlungen und Untersuchungen der Preussischen Stein-und Kohlenfall-Kommission). An account of the proceedings and investigations and regulations of a Prussian commission appointed to investigate accidents due to the fall of rock and coal in mines. Tables. 3000 w. Glückauf—Jan. 4, 1902. No. 45648 B.

Air Compressors.

New Collmann Air Compressors at German Collieries. P. Schulte in *Glückauf.* Illustrated description. 1200 w. Col Guard—Dec. 20, 1901. No. 45273 A.

British Columbia.

The British Columbia Mining Industry in 1901. William M. Brewer. Review of the conditions in the mining districts, the production and matters affecting the industry. 8000 w. Eng & Min Jour—Jan. 4, 1902. No. 45465.

Disasters.

Disaster at Pocahontas Mines. Charles S. Thorne. An account of the disasters occurring on Nov. 14 and 22. 1500 w. Mines & Min—Jan., 1902. No. 45389 C.

The Donibristle Colliery Accident. Gives description of the colliery, and an account of the accident, which was caused by a flow of soft peat or moss into the mine causing the loss of eight lives. Ill. 5500 w. Col Guard—Jan. 3, 1902. No. 45426 A.

Economies.

Small Things in Mining. W. H. Storms. Describes devices recently introduced in California for expediting matters in shaft-sinking. 1500 w. Min & Sci Pr—Dec. 26, 1901. No. 45350.

Firedamp.

The Graduation of Firedamp Test Pipettes (Un Nouveau Mode de Graduation des Eprouvettes à Grison). J. Potier. The graduations indicate directly the inflammable limits of the mixture. 2500 w. 1 plate. Rev Univ des Mines—Dec., 1901. No. 45805 H.

The von Walcher-Gaertner Pneumatophor (Der v. Walcher-Gaertnersche Pneumatophor). Dr. Gustav Gaertner. An answer to R. Daniloff's criticism of this apparatus for breathing in an atmosphere of poisonous gases. 2400 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 28, 1901. No. 45834 B.

Haulage.

See Electrical Engineering Power Applications.

Health.

See Industrial Economics.

Hoisting.

Apparatus to Prevent Mine Cages from Stopping too Hard (Vorrichtung zur Verhütung des Harten Aufsetzens der Fördergestelle). An illustrated description of a delayed-action catch, which does not stop the cage if it is going too fast, the invention of J. Römer. 500 w. Glückauf—Dec. 21, 1901. No. 45646 B.

Hoisting Diagrams.

Speed Curves of Hoisting Engines and their Use in Designing Safety Appliances (Die Graphische Darstellung des Ganges des Fördermaschinen und die Benutzung derselben zum Bau eines Sicherheitsapparates). Hr. Witte. An account of experiments with a Karlik mercury tachograph and electrically-operated safety brakes for hoisting engines for mines. Diagrams. 2 plates. 2400 w. Glückauf—Jan. 11, 1902. No. 45651 B.

Hydraulic Filling.

The Hydraulic Filling-In of Coal Mine Workings at Myslowitz, Silesia (Scheibenförmiger Abbau Mächtiger Flötze unter Anwendung von Versatz mittelst Wasserspülung auf dem Steinkohlenbergwerk Myslowitz bei Myslowitz). Gustav Williger. From the *Zeitschrift des Oberschlesischen Berg-und Hüttenmännischen Vereins,* giving a description of mining thick seams by taking out layers and filling in with sand and waste material hydraulically. 3000 w. Glückauf—Jan. 4, 1902. No. 45649 B.

Mexico.

Notes on the Mines and Minerals of

Guanajuato, Mexico. William P. Blake. Brief historical notes with account of the systems of mining and the minerals found. 2800 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 45791 D.

The Values of Ores in Mexico. N. H. Emmons. An explanation of the peculiar conditions in Mexico which determine the value of a given ore to the miner. 2300 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 45793 D.

Mine Drainage.

Mine Drainage in the Rocky Mountain Region. A. W. Warwick. Gives an idea of the immense expense in handling the water of mines, and describes the methods of pumping now in use, discussing their efficiency, and means of more economical working. Ill. 4700 w. Min Rept—Jan. 9, 1902. Special No. No. 45496 C.

Mine Fire.

The Smuggler Union Mine Fire. An account from the Inspector's report to the Commissioner of Mines, describing the disaster and discussing the causes which resulted in such large fatalities. 1800 w. Mines & Min—Jan., 1902. No. 45391 C.

Mine Patents.

The Cost of Mine Patents. Theodore F. Van Wagenen. A discussion of the mine patenting system, as now operated, the improvements needed and the benefits that would follow. 3800 w. Min & Sci Pr—Jan. 4, 1902. No. 45378.

Oil Wells.

The Drilling of Submarine Oil Wells as Performed at Summerland, Cal. Dwight Kempton. Illustrated description of method used. 800 w. Sci Am—Jan. 18, 1902. No. 45514.

Ore Deposits.

Recent Progress in the Study of Ore Deposits. T. A. Rickard. Concerning recent progress in the study of ore deposits, and the assistance geology has given to mining. 1700 w. Eng & Min Jour—Jan. 18, 1902. No. 45563.

Ore Estimates.

Ore in Sight. J. D. Kendall. Read before the Inst. of Min. & Met. Recommendations tending to reduce the losses due to errors in estimating. Ill. 2800 w. Ir & Coal Trds Rev—Dec. 20, 1901. No. 45269 A.

Shaft Sinking.

Arrangements for Keeping a Borehole Clear During Shaft Sinking (Verfahren und Einrichtung, beim Abteufen von Schächten ein Vorhandenes Bohrloch behufs Ungestörter Wasserlosung Intact zu Erhalten). Eduard Grosse and Josef Srb. The borehole is kept open in order to permit water to drain off, by inserting an inner tube, through which water is pumped. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 21, 1901. No. 45831 B.

Shafts.

Plumbing Deep Shafts of the Tamarack Mine. H. M. Lane. Describes the methods employed and gives an account of some interesting phenomena observed. 4400 w. Mines & Min—Jan., 1902. No. 45384 C.

Structural Steel.

The Uses of Structural Steel for Mining, Milling and Smelting Purposes. E. M. Sprague. The practice of making mining plants practically fireproof has led to the use of this material in the construction of buildings for smelters, cyanide mills, chlorination mills, stamp mills, reduction works, refineries, shaft houses, power houses, gallows frames, etc. 2000 w. Min Rept—Jan. 9, 1902. Special No. No. 45497 C.

Temperature.

Temperature Measurements in Deep Borings (Temperaturmessungen in Tiefbohrlöchern). H. Thumann. An illustrated description of a thermometric apparatus for deep boreholes with an account of subterranean temperature measurements in a boring at Oldau, Germany. 1400 w. Glückauf—Dec. 21, 1901. No. 45645 B.

Veins.

Influences of Country-Rock on Mineral Veins. Walter Harvey Weed. Notes and facts seeming to show a relation between the country-rock and the universal contents of veins. A discussion with conclusions. Ill. 6000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 45788 D.

MISCELLANY.

Aluminum.

Aluminum. Notes on Its Production, Properties and Use. W. Murray Morrison. Abstract of a paper read before the Glasgow Sec. of the Inst. of Elec. Engrs. Considers the price, the reduction of the metal, leading properties, alloys, &c. 1800 w. Elec Engr Lond—Dec. 20, 1901. No. 45257 A.

Austria.

The Mining Industry of Austria in 1900 (Der Bergwerksbetrieb Oesterreichs im Jahre 1900). Statistics of the mining and metallurgical products of all kinds, with tables. 2 parts. 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 14, 21, 1901. No. 45829 each B.

Concentration.

Concentration Practice in Southeast Missouri. R. B. Brinsmade. An illustrated description of the plants of the St. Joe, the Central, and the National Concentrating mills. The gangue of the ore concentrated is limestone, while the minerals are galena, iron pyrites, and nickel-cobalt sulphides. 4500 w. Mines & Min—Jan., 1902. No. 45383 C.

Italy.

Mining and Metallurgy in Italy in 1900 (Bergwerks-und Hüttenproduction Italiens 1900). Statistical tables of all kinds of mining and metallurgical products. 400 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 14, 1901. No. 45830 B.

Lead Mining.

The Linares Lead Mining Industry of Spain. E. Mackay-Heriot. Information concerning the geological features, production, and working of this district. 2400 w. Eng & Min Jour—Jan. 11, 1902. No. 45506.

Mexican Meeting.

The Mexican Meeting of the American Institute of Mining Engineers. Fritz J. Frank. An illustrated account of an interesting and enjoyable trip. 5500 w. Mines & Min—Jan., 1902. No. 45390 C.

Mexico.

Gems and Precious Stones of Mexico. George Frederick Kuntz. A review of the gems known to have been found, and description of the mines, giving much interesting information. 15400 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 45798 D.

Mica.

Opportunities for Improvement in Mica Mining. George W. Colles. A timely presentation of a subject which owes its importance to the new and widely increasing field of usefulness of mica as an electrical insulator. 4000 w. Engineering Magazine—Feb., 1902. No. 45826 B.

Petroleum.

Oil and Gas in the Kansas-Indian Territory and Texas Fields. Information from a bulletin by George I. Adams, issued by the United States Geological Survey. 1600 w. Eng & Min Jour—Jan. 18, 1902. No. 45561.

Oil in Colorado. Arthur Lakes. Discusses the geology of the deposits, and the various horizons in which signs of oil have been found. 2500 w. Mines & Min—Jan., 1902. No. 45388 C.

Platinum.

The Discovery of Platinum in Wyoming. Wilbur C. Knight. An account of the discovery with assays made from samples. 800 w. Eng & Min Jour—Dec. 28, 1901. No. 45239.

Quicksilver.

New Method of Quicksilver Extraction. J. H. Jory. Describes the method and states its advantages. The most essential part of the new method is the electrolytic sluice. 1500 w. Min & Sci Pr—Dec. 28, 1901. No. 45349.

Quicksilver. R. S. Baverstock. Discusses its occurrence, characteristics, production, methods of reducing ores, uses, &c. 3800 w. Min & Sci Pr—Jan. 4, 1902. No. 45376.

Some Occurrences of Gases in a Quicksilver Mine. Phil Rearden. A description of an experience in a California mine, with diagrams. 1000 w. Min & Sci Pr—Jan. 18, 1902. No. 45584.

Tasmania.

Wolfram Near Pieman Heads (T.). George A. Waller. Describes the deposits and discusses their origin. 1500 w. Aust Min Stand—Nov. 14, 1901. Serial. 1st part. No. 45264 B.

Zinc.

The Missouri and Arkansas Zinc-Mines at the Close of 1900. Eric Hedburg. Discussion of this paper which was read at the Richmond meeting. 3500 w. Trans Am Inst of Min Engrs—Feb., 1902. No. 45795 D.

Zinc Smelting in the United States in 1901. Walter Renton Ingalls. A review of the various districts and the improvements introduced. Ill. 4300 w. Eng & Min Jour—Jan. 4, 1902. No. 45464.

RAILWAYS AND TRAMWAYS

CONDUCTING TRANSPORTATION.

Disaster.

The Disaster on the Liverpool Overhead Railway. An account of the fire which resulted in the loss of six lives and much damage to the Dingle Station and rolling stock. 2000 w. Elec Rev, Lond—Jan. 3, 1902. No. 45423 A.

Speed.

British and American Expresses. Aiming to prove Britain well in advance of America as regards the volume and average speed of her express traffic. 1400 w. Transport—Jan. 10, 1902. No. 45507 A.

The Speed of Express Trains in Europe and the United States (Vitesse de Marche des Trains Express en Europe et aux Etats-Unis). A large table, taken from *"Archiv für Eisenbahnwesen"*, giving comprehensive statistics of fast trains in Europe and America. 1200 w. Revue Technique—Dec. 10, 1901. No. 45668 D.

Train Resistance.

New Formulae for Train Resistance (Nouvelles Formules de la Résistance des Trains). A comparison of various train resistance formulae, with diagram. 1000

w. Génie Civil—Jan. 11, 1902. No. 45665 D.

Tunnel Disaster.

The Fourth Avenue Tunnel Collision. Remarks on the cause of the disaster with editorial discussion. 5000 w. R. R. Gaz—Jan. 17, 1902. No. 45538.

The New York Central Accident—Electricity—Protection by Signals. S. S. Neff. A review of improvements necessary to insure safety on electric roads, with some reference to warnings in letters by Mr. George Westinghouse. 2800 w. R. R. Gaz—Jan. 24, 1902. No. 45734.

The New York Central Tunnel Tragedy. Editorial comments with illustration of the wrecked engine. 800 w. Sci Am—Jan. 18, 1902. No. 45513.

The Park Avenue Tunnel Disaster. Editorial discussion of this recent accident which caused loss of life and serious injuries. 3000 w. Eng News—Jan. 16, 1902. No. 45485.

The Testimony Concerning the Tunnel Collision. Gives the essential parts of the testimony brought out at the Coroner's inquest thus far, with editorial comment on the false impressions formed from the manner of conducting the investigation. 2000 w. R R Gaz—Jan. 24, 1902. No. 45733.

United States.

Development of Transportation in the United States. Angus Sinclair. Extracts from paper prepared for the Year Book of the Agricultural Department of the United States. A review of the early history of railroading and locomotive building. Ill. 3500 w. Loc Engng—Jan., 1902. No 45317 C.

Unloading.

Method of Unloading Passengers from Moving Trains. Illustrates and describes the use of "saddle cars" successively taken up and dropped from a moving train. 700 w. Sci Am—Jan. 4, 1902. No. 45355.

MOTIVE POWER AND EQUIPMENT.

Bergdorf-Thun.

The Bergdorf-Thun Electric Railway (Le Chemin de Fer Electrique à Voie Normale de Berthoud à Thoune, Suisse). Henry Martin. A very well illustrated description of this Swiss polyphase railway and its rolling stock. 1 plate. 6000 w. Génie Civil—Jan. 11, 1902. No. 45664 D.

Booster.

See Electrical Engineering, Distribution.

Brighton.

The Brighton Corporation Tramways. Illustrated detailed description of construction. 2800 w. St Ry Jour—Jan. 4, 1902. No. 45319 D.

Car Equipments.

Electric Car Equipments and Their Maintenance. A. W. Wigram. Read before the Newcastle section of the Inst. of Elec. Engrs. A criticism on some constructional details prominent in modern practice, and a few notes on maintenance. 9300 w. Elec Engr, Lond—Dec. 27, 1901. No. 45283 A.

Car Service.

Mr. Midgley's Car Service Investigations. A review of Mr. J. W. Midgley's seventh circular letter, which discusses plans that have been tried or suggested to promote greater activity in freight car performance. 2000 w. Ry Age—Jan. 17, 1902. No. 45559.

Cars.

Pressed Steel Car of 100,000 lbs. Capacity—Car for the Pennsylvania R. R. Illustrations and brief description, with general dimensions. 600 w. Ry & Engng Rev—Jan. 18, 1902. No. 45570.

The "California" or Combination Car. W. E. Partridge. Illustrates and describes this type of car, which has a closed body with open ends or platforms, discussing also similar types. 2200 w. St Ry Rev—Jan. 15, 1902. No. 45567 C.

36-foot Box Car with Steel Center Sills —Chicago, Milwaukee & St. Paul Railroad. Illustrated description. 500 w. R R Gaz.—Jan. 17, 1902. No. 45539.

Vanderbilt Steel Tank Car, 12,000 Gallons Capacity. Illustrated description of a car designed for the Equitable Land and Oil Company, to be used in transporting oil from the Texas oil fields to St. Louis. The largest capacity tank cars in use. 800 w. Am Engr & R R Jour—Jan., 1902. No. 45309 C.

Detroit.

Express Service in Detroit. An illustrated description of this service, which has developed rapidly and is growing in popularity. 2000 w. St Ry Rev—Jan. 15, 1902. No. 45568 C.

Draft Gear.

Westinghouse Friction Draft Gear (Westinghouse - Reibungs - Zugvorrichtung). An illustrated account of this draft gear and its successful operation. 3000 w. Glasers Ann—Jan. 1, 1902. No. 45613 D.

Electric Equipment.

The Electric Equipment of the Manhattan Elevated. A short description of the train equipment, and a more complete illustrated description of the power plant of the New York Elevated railway. 2500 w. R R Gaz—Jan. 17, 1902. No. 45536.

Electrical Equipment of the Manhattan Elevated Railway. Facts and views concerning this important instalation. 1700 w. Elec Wld & Engr—Jan. 11, 1902. Serial. 1st part. No. 45467.

Electric Traction on the Manhattan Elevated Railway (Mittheilungen über den Elektrischen Betrieb auf der Manhattan Bahn). Hr. Sarre. An illustrated general account of the electrical equipment of the road and of the power station, with map and diagrams. 2 plates. 3000 w. Glasers Ann—Dec. 15, 1901. No. 45612 D.

Electric Traction.

Concerning Some Dangers from Electric Traction. A letter from George Westinghouse, with editorial showing that the use of electricity in the Park Ave. tunnel might have made the recent accident even more serious. 900 w. R R Gaz —Jan. 17, 1902. No. 45535.

Present Tendencies in Electric Traction. Louis Bell. A brief review of the history of electric traction, with a discussion of the present tendencies. 3500 w. Elec Rev, N. Y—Jan. 11, 1902. No. 45457.

Hamburg, Germany.

The Street Railway Company of Hamburg, Germany. Heinrich Vellguth. Gives the history of the company, with an illustrated detailed description of the construction and equipment of the tramways and information related. 9400 w. St Ry Jour—Jan. 4, 1902. No. 45318 D.

Interurban.

Chicago & Joliet Interurban Railway. A. S. Kibbe. Illustrated description of an interurban road recently opened to service, its construction and equipment. 7000 w. St Ry Rev—Jan. 15, 1902. No. 45565 C.

Locomotives.

American Locomotives in England. Charles Rous-Marten. The reply of the writer to an extended criticism called out by an article of his published June 14th, 1901. 4000 w. Engr, Lond—Dec. 20, 1901. No. 45278 A.

Baldwin Eight-Coupled Locomotive for the Lehigh Valley R. R. Illustrated description of a recently built switching engine, interesting because of its type and extreme weight. 900 w. Ry & Engng Rev—Jan. 25, 1902. No. 45782.

Chautauqua Type Passenger Locomotive—Buffalo, Rochester and Pittsburg Railway. Engravings and description of the principal details of these recently built engines. 900 w. Ry Mas Mech—Jan. 1902. No. 45360.

Chautauquä Type· Passenger Locomotives. Illustrates and describes the heaviest four-coupled passenger locomotives ever built. Used in service between New York and Philadelphia on the Central Railroad of New Jersey. 900 w. Am Engr & R R Jour—Jan., 1902. No. 45311 C.

Compound Locomotives, and the Richmond Locomotive Exhibit. H. Wade Hibbard. Describes the Pan-American exhibit of the Richmond Works which has been given to Sibley College, with remarks on this class and a statement of its advantages. 1500 w. Sib Jour of Engng—Jan., 1902. No. 45753 C.

Compound Passenger and Goods Locomotives for the Hungarian State Railways. Illustrates and describes an engine with two coupled driving axles, a bogie in front and trailing wheels in the rear, for hauling heavy trains at a high speed. 1200 w. Engng—Dec. 27, 1901. No. 45-295 A.

Compound Tank Locomotive, Indian Netherlands Railway, Java. Illustration with description of an engine employed on the Java narrow-gauge railways, and an account of the service. 1000 w. Engr, Lond—Jan. 3, 1902. Serial. 1st part. No. 45439 A.

Electric Breakdown Locomotive. Gives an illustration of an electric locomotive designed for breakdown purposes on the Waterloo and City Railway, London, with description, and notes on the working of this railway. 800 w. Engr, Lond—Jan. 17, 1902. No. 45779 A.

English Locomotives at the Paris Exposition (Die Englischen Locomotiven auf der Pariser Weltausstellung 1900). Rolf Sanzin. Illustrated description of various British locomotives. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 27, 1901. No. 45698 B.

European Railway Jottings. Charles Rous-Marten. Discusses the single-driven engines recently built for the Great Northern Railway, and other recent locomotives. 1800 w. Loc Engng—Jan., 1902. No 45314 C.

Four-Cylinder Balanced Compound Locomotive. Charles M. Muchnic. Engravings illustrating a design based on the principles of the successful de Glehn compounds, combined with the simplicity which characterize American practice. 1500 w. Am Engr & R R Jour—Jan., 1902. No. 45313 C.

Four-Cylinder Compound Decapod Locomotive—Largest Engine Yet Built. Illustrates and describes this interesting engine built for the Atchison, Topeka & Santa Fe Railway, comparing it with other large engines. 2000 w. Ry & Engng Rev —Jan. 11, 1902. No. 45469.

Lignite-Burning Consolidation Locomotive—Bismarck, Washburn & Great Falls. General description, with illustrations, of a recently built locomotive. The first of its kind, as to wheel arrangement, in the United States. 700 w. R R Gaz—Jan. 10, 1902. No. 45480.

Locomotive Construction in the United States (La Construction des Locomotives aux Etats-Unis). Daniel Bellet. An illustrated account of various United States locomotives for domestic and foreign use. 5400 w. Revue Technique—Dec. 25, 1901. No. 45673 D.

New Culm-Burning Switching Locomotive. Describes locomotives of the

Wootten type, being built for the Delaware & Hudson. Ill. 800 w. Ry Age—Dec. 27, 1901. No. 45238.

Oil-Burning Locomotives on the Southern Pacific. Illustrates and describes oil-burning apparatus used very successfully on the western lines of the Southern Pacific. 800 w. R R Gaz—Jan. 24, 1902. No. 45736.

Passenger Mogul for the New York, Ontario and Western. Illustrated description of a large culm-burning engine for fast freight and passenger service. 1000 w. Ry Age—Jan. 24, 1902. No. 45727.

Prairie Type Passenger Locomotive with Traction Increaser—Atchison, Topeka & Santa Fe. Drawings and description, showing two ways of applying the increasers. Compressed air from the air-brake system is used to operate them. 900 w. R R Gaz—Jan. 17, 1902. No. 45540.

Some Factors Affecting the Power of Locomotives. Abstract of a paper presented by Prof. W. F. M. Goss before the Dec. meeting of the New England R. R. Club, with diagrams. A discussion of the effect of speed on tractive efforts. 4500 w. R R Gaz—Jan. 24, 1902. No. 45735.

Tank Locomotive for the Vajda-Hunyad Mine, Hungary. Illustrated description of these narrow-gauge engines, with four coupled axles, the two end axles being made to pivot for taking short sharp curves. 400 w. Engng—Jan. 3, 1902. No. 45429 A.

London.

The City and South London Railway. An interesting illustrated account of the development and improvement of this pioneer electric railway in England, its equipment, operation, &c. 6600 w. Tram & Ry Wld—Dec. 12, 1901. No. 45510 B.

Lubrication.

Lubrication of Cars. George P. Zachritz. Extracts from a paper presented at the Dec. meeting of the Northwest Ry. Club. Discusses the things to be considered in successfully and economically preventing journals from heating. 2000 w. R R Gaz—Jan. 24, 1902. No. 45738.

Paris.

Development of Street Railway Traffic in Paris. E. J. Lavalard. Reviews the history of the street transportation systems, including the omnibus as well as tramway lines. 1800 w. St Ry Jour—Jan. 4, 1902. No. 45320 D.

Portsmouth.

The Portsmouth Electric Tramways. Full illustrated description of these tramways which form the largest municipal system in the South of England. 1700 w. St Ry Jour—Jan. 4, 1902. No. 45323 D.

Re-arrangement.

Re-arrangement of Power Generating and Distributing Scheme at Worcester, Mass. Discusses questions involving the relative economy of alternating and direct-current transmission, the utilizing of present power-house equipments when roads are consolidated, output, capacity, &c. Ill. 3000 w. St Ry Rev—Jan. 15, 1902. No. 45569 C.

Rheydt-Gladbach.

See Electrical Engineering, Generating Stations.

Salford.

Salford Corporation Electric Tramways. History of the tramway service with illustrated description of the recent re-equipment and reconstruction on the overhead wire system. 4000 w. Tram & Ry Wld—Dec. 12, 1901. No. 45411 B.

San Francisco.

Rail Feeder Construction in San Francisco. S. L. Foster. An illustrated account of the recent work of the Market Street Railway Company. 1700 w. St Ry Jour—Jan. 4, 1902. No. 45321 D.

Stray Current.

Protection of Water Pipe from Electrolysis. E. B. Ellicott. A statement of conditions existing in large cities where electric railways are operated, and the remedy, with general discussion of the subject. Ill. 7500 w. Jour W Soc of Engrs—Dec., 1901. No. 45307 D.

See also Electrical Engineering, Measurement.

Suspended Railway.

The Barmen-Elberfeld-Vohwinkel Suspended Railway (Le Chemin de Fer Suspendu de Barmen-Elberfeld-Vohwinkel, Allemagne). Alfred Boudon. A well illustrated description of this interesting German elevated railway, designed by E. Langen. 1 plate. 3500 w. Génie Civil—Dec. 28, 1901. No. 45660 D.

The Langen Suspended Railway of Barmen-Vohwinkel-Elberfeld. Prof. Dolezalek. Illustrated description of the road, equipment and operation. 1000 w. Sci Am—Jan. 25, 1902. No. 45703.

Tires.

Flat Spots that Develop in Driving Wheel Tires. I. F. Wallace. Reviews the history of driving wheel tires claiming that it is speed and counter balance combined that cause the trouble. 1500 w. Ry Mas Mech—Jan., 1902. No. 45361.

Tunnel Equipment.

Comments on the Electrical Equipment of the New York Central Tunnel. Letters from Mr. George Westinghouse in regard to the dangers of electric traction, with replies from various writers, and editorial. 6000 w. St Ry Jour—Jan. 25, 1902. No. 45722 D.

Underground.

The Transformation of the Underground Railway. A retrospective view of the situation which led to the attitude taken by the Board of Trade is commenced. 1400 w. Elec Rev, Lond—Jan. 3, 1902. Serial. 1st part. No. 45422 A.

Zossen.

High-Speed and Long-Distance Electric Railways (Ueber Elektrische Schnell und Fernbahnen). O. Lasche. A paper before the Verein für Eisenbahnkunde, by the chief engineer of the Allemeine Elektrizitätsgesellschaft, giving a general account of the advantages of electric traction, and details of the high-speed experiments between Berlin and Zossen. Diagrams. 6500 w. Glasers Ann—Dec. 15, 1901. No. 45611 D.

NEW PROJECTS.

Australia.

The Trans-Australian Railway Scheme. Stafford Ransome. Map, with account of a proposed plan to connect the capitals of the various states by means of one line of railway reaching from the east to the west coast. 2000 w. Engr, Lond—Dec. 27, 1901. No. 45288 A.

Extensions.

The Glasgow and Southwestern's Extensions at Glasgow. An illustrated description of a great terminal enlargement in the heart of a busy city, where the approach is over an important river as well as numerous streets. 2500 w. Transport —Jan. 3, 1902. No. 45412 A.

Ship Railway.

See Civil Engineering, Canals, Rivers and Harbors.

PERMANENT WAY AND BUILDINGS.

Berlin.

The Electric Elevated and Underground Railways in Berlin (Die Elektrischen Hoch und Tiefbahnen in Berlin). Hugo Koestler. A very well illustrated account of this rapid transit system. 3 plates. 7500 w. Oesterr Wochenschr f d Oeffent Baudienst—Nov. 23, 1901. No. 45680 B.

Monorail.

A Comparison of Single and Double Rail Track (Chemins de Fer à Une et à Deux Files de Rails Comparés). R Philippe. An examination of the resistance of double rail track upon curves of various radii, in comparison with the various monorail systems. 8000 w. 1 plate. Ann des Ponts et Chaussées. 2 Trimestre 1901. No. 45816 E + F.

New Plant.

New Yards and Shops of the Central Railroad of New Jersey at Elizabethport, N. J. Illustrations and description. The buildings are of monolithic concrete construction. Explains the traffic conditions that had to be provided for, and much information of the shops and their equipment. 4000 w. R R Gaz—Dec. 27, 1901. Serial. 1st part. No. 45233.

Rack Railway.

The Barmen Mountain Railway (Die Barmer Bergbahn). Direktor Daubner. A well illustrated description of this electric railway, partly rack and partly adhesion, between Barmen and some of the neighboring places in Rhenish-Prussia. The power house is also described and load curves given. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 4, 1902. No. 45606 D.

Retaining Walls.

Widening a Section of the New York Rapid Transit Railway by Moving the Side Walls. Illustrated description of the moving of brick-faced concrete retaining walls, placing them on new foundations. 1500 w. Eng News—Jan. 9, 1902. No. 45368.

Roundhouse.

Collinwood Roundhouse. Illustrates and describes details and appliances of this interesting terminal on the L. S. & M. S. Ry. 900 w. Am Engr & R R Jour—Jan., 1902. No. 45310 C.

Shops.

West Chicago Shop of the Chicago and North-Western Railroad. R. T. Shea. Illustrated detailed description. 2200 w. Loc Engng—Jan., 1902. No. 45315 C.

Signaling.

Interlocking and Signal Work on the Union Pacific. Illustrates and describes recent work between Council Bluffs, Ia., and Gilmore, Neb., including the Union Station at Omaha. 1500 w. Ry Age—Jan. 17, 1902. No. 45560.

Stray Currents.

See Electrical Engineering, Measurement.

Surface Contact.

The Barbillon and Griffisch Surface-Contact Tramway (Traction Electrique des Tramways Système Barbillon et Griffisch par Distributeur Automobile à Echappement). J. Reyval. An illustrated description of a system in which a small electric motor car runs in a closed conduit parallel to the tracks and successively energizes contact plugs between the rails. 2800 w. Revue Technique—Dec. 25, 1901. No. 45670 D.

Terminal Problem.

Proposed Solution of the New York Central Terminal Problem. A general outline of the plan proposed for operating the Park Ave. tunnel. 1600 w. Sci Am—Jan. 25, 1902. No. 45704.

Tracklaying.

Re-Laying of Rails (Schienen-Neulage). Franz Baumgartner. A practical detailed description of the relaying of railway track. 6000 w. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 7, 1901. No. 45686 B.

Tunnel Improvement.

The New York Central's Plans for the Improvement of the Park Ave Tunnel. Announcement of the changes in the method of operating that has been decided upon, with editorial discussion, and report of the investigation of the disaster. 5700 w. Eng News—Jan. 23, 1902. No. 45731.

TRAFFIC.

Freight-Car Hire.

The Per Diem Basis for Settlement of Freight Car Hire. J. M. Daly. A discussion of the advantages and objections relating to this system, generally favorable to its adoption. 3400 w. R. R. Gaz—Jan. 10, 1902. No. 45482.

Freight-Carrying.

Electric Roads as Freight Carriers. Editorial discussion of this subject, and the type of road which may find profit in hand-to its adoption. 3400 w. R R Gaz—Jan. 4, 1902. No. 45322 D.

Freight Interchange.

Switching Yards of the Chicago Transfer & Clearing Co. Illustrated description of these new switching and transfer yards. The fundamental principle is the reduction of the great delays and expense incurred by the present system. Also editorial discussion. 6800 w. Eng News—Jan. 2, 1902. No. 45346.

Germany.

Freight Movement on German Railways (Die Güterbewegung auf Deutschen Eisenbahnen im Jahre 1900 im Vergleich zu der in den Jahren 1899, 1898 und 1897). Statistical tables, particularly of mining and metallurgical products. 600 w. Glückauf—Nov. 23, 1901. No. 45642 B.

Inter-State Commerce.

Proposed Amendments of the Inter-State Commerce Act. Walker D. Hines. A protest against the proposed legislation to amend the act, with editorial. 2500 w. Ry & Engng Rev—Jan. 18, 1902. No. 45571.

Railway Traffic.

Railways and Industry. H. T. Newcomb. Reviews the changes brought about by the railway system, especially in America. 2500 w. Gunton's Mag—Jan., 1902. No. 45358 C.

Rates.

The Inadequate Powers of the Interstate Commerce Commission. Edward P. Bacon. Discusses the powers of this commission and the proposed amendments, and the subject of railway rates. 5000 w. N Am Rev—Jan., 1902. No. 45303 D.

Simplon.

The Lines of Approach to the Simplon (Le Linee di Accesso al Sempione). A report of the discussion in the Chamber of Deputies under which the various Italian railways are to partake in the traffic through the Simplon tunnel. 1000 w. Gior d Lav Pubb e delle Str Ferr—Dec. 25, 1901. No. 45807 D.

MISCELLANY.

American Railways.

Some Notes Suggested by Colonel Constable's Report on American Railways. Colonel G. Boughey. A review of the report named. 3300 w. Transport—Jan. 17. 1902. No. 45762 A.

Conferences.

The Indian Locomotive Conference in Calcutta. A report of matters discussed, with editorial. 4800 w. Engr, Lond—Jan. 17, 1902. No. 45776 A.

Early Railway.

An Early London Railway. Gives the history of a short line on which the atmospheric system was given a trial in 1837, but proved a failure. The line was opened for traffic in 1844 and its various experiences are narrated. 2800 w. Engr, Lond—Dec. 27, 1901. No. 45293 A.

East Indies.

Railways and Steam Tramways of the Dutch East Indies. A report on the railways of Java and Sumatra by J. W. Post, formerly engineer of the State Railways of the Dutch East Indies. 3000 w. Engr, Lond—Dec. 27, 1901. No. 45291 A.

Italian Railways.

Convention of the Provincial Administration of Milan, etc. (Convenzioni Stipulate coll' Amministrazione Provinciale di Milano, etc.). A report of the discussion of the joint convention of the provinces of Milan, Turin, and the Italian Mediterranean railways. Two articles. 4000 w. Riv Gen delle Ferrovie—Jan. 5, 12, 1902. No. 45800 each B.

Portchester Railway.

The New York and Portchester Railway Hearing. Presents testimony relating to the engineering and financial features of this undertaking. 7000 w. St Ry Jour—Jan. 4, 1902. No. 45325 D.

Supplies.

Stock Rooms and Stock Keeping of the Metropolitan Street Railway Company, New York City. An illustrated description of the storerooms, and methods of purchasing and distributing. 2500 w. St Ry Jour—Jan. 4, 1902. No. 45324 D.

Tube Railways.

Tube Railways. Editorial called out by the recent accident in the Liverpool elevated railway, discussing the dangers of tube railways, and their construction. 1500 w. Engr, Lond—Jan. 10, 1902. No. 45555 A.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical Times. *w.* London.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.

Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Ingenería. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Científico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Autobiography.

Reminiscences of General Herman Haupt. Written by Himself, with Notes and a Personal Sketch by Frank Abiel Flower. Size 7 by 10 in. Pp. 331. Washington, 1901.

A most interesting volume of experiences in the engineering work during the Civil War, including hitherto unpublished official orders, personal narratives of important military operations, interviews with President Lincoln and members of his cabinet, and much valuable matter otherwise inaccessible. The history of the engineering work on the Hoosac Tunnel, and of other important civil engineering operations is given, the whole forming an account of engineering during and after the war at first hand by one who can say of it: "All of which I saw, and part of which I was."

Marine Engineering.

Practical Marine Engineering. For Marine Engineers and Students with Aids for Applicants for Marine Engineers Licenses. By William F. Durand. Professor of Marine Engineering at Cornell University. Size 6 in. by 9 in. Pp. 706. Price $5.00. New York: Marine Engineering Inc. 1902

A most complete working treatise on marine engineering, discussing not the design of marine engines, but rather the arrangement and operation, including not only the main engines, but also the auxiliaries, including electrical and refrigerating machinery. The operation of the machinery is explained in a clear and simple manner, and numerous examples are given in explanation of the computations which the working marine engineer may be called upon to make.

These computations and questions form an excellent preparation for examinations for licenses, having been prepared with that end in view. The book fills a void which has needed attention, and does it well.

Boilers.

Water-Tube Boilers. Based on a Short Course of Lectures delivered at University College, London. By Leslie S. Robertson. Size 5½ by 8½ in. Pp. 213. Price $3.00. New York: D. Van Nostrand Co. 1902.

A general and popular treatise on water-tube boilers for marine use, based largely on the author's translation of the larger work of M. Bertin. Numerous illustrations of the various designs of water-tube boilers are given, together with auxiliary apparatus, feed regulators, etc., also the interim report of the Admiralty Commission appointed to discuss the questions connected with the adoption of various types of boilers in the British Navy.

Municipalities.

Municipal Administration. By John A. Fairlie. Size 6 in. by 9 in. Pp. 448. Price $3.00. New York: The Macmillan Company. London: Macmillan & Co., Ltd., 1901.

A scholarly treatise on the various problems connected with municipal administration, including the history of municipal growth in Europe and in the United States; questions of health, safety, education, improvements and general administrative organization.

The present tendencies in the growth of cities are discussed in a manner free from partisanship or prejudice, and the work is an admirable example of the manner in which problems of such vital importance should be considered.

Architecture.

Architectural Engineering. With especial reference to High Building Construction. By Joseph Kendall Freitag. Size 6 in. by 9 in. Pp. 407. Price $3.50. New York: John Wiley & Sons. London: Chapman & Hall. 1901.

An engineering study of the steel skeleton building, including not only the questions of strength and stability, but also the details of interior construction, finishing, fire proofing, drainage, etc. Numerous illustrations of typical tall buildings in American cities are given, including floor plans, showing arrangement of rooms, lighting, elevators, and all the engineering features involved in modern architecture of business buildings. The work is an excellent example of the manner in which engineering has entered into the fundamental work of the architectural profession.

Iron.

Cast Iron. A Record of Original Research. By William J. Keep. Size 6 in. by 9 in. Pp. 225. Price $2.50. New York: John Wiley & Son. London: Chapman & Hall, Ltd. 1902.

A complete account of the author's researches into the conditions accompanying the behaviour of cast iron in cooling, including the improved methods of testing cast iron, and the practical application in the foundry of the principles set forth. Numerous diagrams of test pieces, curves, etc., are given, and the work enables the whole of Mr. Keep's important researches to be studied together. The work is an important contribution to original knowledge concerning cast iron.

Annual.

Annuaire pour l'An 1902. Publié par le Bureau des Longitudes. Size 4 in. by 6 in. Price 1 franc 50 centimes. Paris: Gauthier Villars. 1902.

The current issue of the well-known annual, containing an abstract of the large almanac of the Bureau des Longitudes, together with much useful general scientific information by such specialists as: MM. Poincaré, Cornu, Guyou, and Janssen. Many valuable physical and general tables are given, the whole forming a most convenient book of reference for the year.

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Transmission.

Power and Transmission. By E. W. Kerr. Size 6 in. by 9 in. Pp. 356. Price $2.00. New York: John Wiley & Sons. London: Chapman & Hall. 1902.

A text book upon the general design of machinery of transmission, including shafting, belting, levers, piping, etc. Also of power generation, including steam, gas, and water power, and compressed air. The work is prepared from the author's lectures as used at the University of Texas, and is well adapted for the presentation of the general principles of power generation and transmission to the student of mechanical engineering.

Cast Iron.

Metallurgy of Cast Iron. A Complete Exposition of the Processes involved in its Treatment, Chemically, and Physically, from the Blast Furnace through the Foundry to the Testing Machine. By Thomas D. West. Third Edition. Size 5 in. by 7 in. Pp. 627. Price $3.00. Cleveland, Ohio: The Cleveland Printing and Publishing Co. 1901.

A new edition of Mr. West's well-known book, containing much new matter based upon foundry practice in America and Europe. An excellent feature of this edition is the compilation of the tests of the American Foundrymen's Association, which are of especial value because they include tests upon a number of bars of different grades poured at the same temperature. The practical character of the work renders it especially valuable to owners and operators of foundries.

Engineering.

The Mechanics of Engineering. Volume I. Kinematics, Statics, Kinetics, Statics of Rigid Bodies, and of Elastic Solids. By A. Jay DuBois. Size 8 in. by 11 in. Pp. 634. Price $7.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. 1902.

A fundamental treatise upon the principles of mechanics, forming one of the Yale Bicentennial publications. The work forms a record of the present condition of the study of mechanics of engineering, and as such is a monumental contribution, not only to the state of the subject as taught at Yale University, but also of the position of Professor DuBois, as an expounder of the science of engineering.

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